AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF PAGES
N/A	1	115

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0009	19 OCT 01	N/A	SPEC. NO. 1034/1189

6. ISSUED BY CODE

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
SACRAMENTO, CALIFORNIA 95814-2922

7. ADMINISTERED BY *(If other than Item 6)* CODE

DISTRICT ENGINEER
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922
ATTN: CONTRACTING DIVISION

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

CODE FACILITY CODE

(√) 9A. AMENDMENT OF SOLICITATION NO.

X DACW05-01-R-0030

9B. DATED *(SEE ITEM 11)*
13 SEP 2001

10A. MODIFICATION OF CONTRACTS/ORDER NO.
N/A

10B. DATED *(SEE ITEM 13)*
N/A

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(√) A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not, ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

JET GROUT SECTIONS, CONTRACT 1/JET GROUT TEST
AMERICAN RIVER WATERSHED PROJECT (COMMON FEATURES), CALIFORNIA

2 ENCLS

1) REVISED PAGES: 00700 - 179, 01506 (16 PAGES), 02332 (46 PAGES) AND 02334 (50 PAGES).

2) REVISED DRAWINGS AS INDICATED ON 00700 - 179.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*	16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*

15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
(Signature of person authorized to sign)		BY *(Signature of Contracting Officer)*	

0020	FABRICATION OF CUTTINGS				
0020AA	0 TO 350	350	EA	$_____	$_____
0020AB	351 & OVER	180	EA	$_____	$_____
0021	EROSION CONTROL	1	JOB	LS	$_____
0022	SITE L2 SITE EXCAVATION TO DETERMINE PRECISE LOCATION AND POSITION	1	JOB	LS	$_____
0023	SITE L3 SITE EXCAVATION TO DETERMINE PRECISE LOCATION AND POSITION	1	JOB	LS	$_____
0024	SITE L4 SITE EXCAVATION TO DETERMINE PRECISE LOCATION AND POSITION	1	JOB	LS	$_____
0025	SITE L4A SITE EXCAVATION TO DETERMINE PRECISE LOCATION AND POSITION	1	JOB	LS	$_____
0026	SITE R2 SITE EXCAVATION TO DETERMINE PRECISE LOCATION AND POSITION	1	JOB	LS	$_____
0027	FILL TWO HOLLOW SECTIONS OF BROKEN PIPE AT 14+180	1	JOB	LS	$_____
0028	EXCAVATION				
0028AA	0 TO 4000	4000	CM	$_____	$_____
0028AB	4001 & OVER	3500	CM	$_____	$_____
0029	BITUMINOUS COURSE	75*	MT	$_____	$_____
0030	AGGREGATE SURFACING	1420*	CM	$_____	$_____
0031	BITUMINOUS SURFACE TREATMENT	3400*	SM	$_____	$_____
0032	EROSION AND SEDIMENT CONTROLS	1	JOB	LS	$_____
0033	***SECONDARY LINE JET GROUT TREATMENT, PARTIAL COLUMN***				
0033AA	***0 TO 800***	***800***	***SM***	***$_____***	***$_____***
0033AB	***801 & OVER***	***700***	***SM***	***$_____***	***$_____***

28	STAGING AREA AT STA. 3+520		
29	ORTHOPHOTO, SECTION L2	1	
30	PLAN, SECTION L2		
31	DETAIL, SECTION L2		
32	DETAIL, SECTION L2		
33	ORTHOPHOTO, SECTION L2		
34	PLAN, SECTION L3	1	
35	DETAIL, SECTION L3		
36	ORTHOPHOTO, SECTION L4 AND L4A		
37	ORTHOPHOTO, SECTION L4		
38	PLAN, SECTION L4 AND L4A		
39	DETAIL, SECTION L4	1	
40	DETAIL, SECTION L4A	1	
41	RIGHT BANK, SURVEY CONTROL POINTS		
42	CUTOFF WALL PROFILE, RIGHT BANK		
43	ACCESS TO SECTION R2		
44	ACCESS TO SECTION R2		
45	ORTHOPHOTO, SECTION R2		
46	PLAN, SECTION R2		
47	DETAIL, SECTION R2	1	
48	R2 ACCESS ROAD REGRADING AND PRECAUTIONS		
49	INTER-CONNECTION BETWEEN SCB SLURRYWALL AND JET GROUT WALL	1	*
50	DETAIL FOR HIGHWAY 160 JET GROUT WALL		
51	DETAIL FOR LIGHT RAIL JET GROUT WALL	1	
52	DETAIL FOR RAILROAD CROSSING, SECTIONS L3		
53	AND L4		
53	DETAIL FOR RAILROAD CROSSING, SECTION R2		
54	MISCELLANEOUS DETAILS		
55	ROAD SURFACING DETAIL		
56	MISCELLANEOUS DETAILS		
57	UTILITIES & CROSSINGS – POINTS OF CONTACTS- NOTIFICATONS SUMMARY, NOTES		
58	NORTH & SOUTH BANKS AMERICAN RIVER, UTILITIES & CROSSINGS DATA	1	
59	NORTH & SOUTH BANKS AMERICAN RIVER, BROKEN PIPE @ APPX 14+180, GENERAL PLAN		
60	NORTH & SOUTH BANKS AMERICAN RIVER, BROKEN PIPE @ APPX 14+180		

STANDARD DRAWINGS

(Attached to SPECIFICATION SECTION: TEMPORARY CONSTRUCTION FACILITIES)

Project Sign	150-25-1186
Sign Details	150-25-1232
Safety Sign	80-25-707
Hard Hat Sign	80-25-774

(End of clause)

252.236-7002 OBSTRUCTION OF NAVIGABLE WATERWAYS. (DEC 1991)

(a) The Contractor shall --

(1) Promptly recover and remove any material, plant, machinery, or appliance which the contractor loses, dumps, throws overboard, sinks, or misplaces, and

SECTION TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01506

REQUIREMENTS AND ISSUES SPECIFIC TO INDIVIDUAL SITES (SECTIONS)

-- End of Section Table of Contents --

SECTION 01506

REQUIREMENTS AND ISSUES SPECIFIC TO INDIVIDUAL SITES (SECTIONS)

PART 1 GENERAL

This section addresses requirements and issues which are specific to individual sites or sections as opposed to the previous section "General Requirements" which apply to more than one section or site. The requirements on this section are in addition to those in other parts of these specification and plans including but not limited to sheets with the designation "1034-U-(number)" and specification section 01505.

A copy of every document, including but not limited to permits, which are sent to or received from any other entity in pursuit of this work, shall be provided to the Contracting Officer and another copy kept by the Contractor at the site of the work.

As referred to in these plans and specifications, "north" bank of the river refers to the "right" bank and "south" bank refers to the "left" bank. The terms: "reach", "site" and "section" (as referring to a specific work area) are also synonymous. The codes starting with "R" or "L" with another number such as "L2" refer to the reach or site as shown on the drawings and described in these specifications.

"Union Pacific's Western Tracks" refer to the railroad tracks just upstream of Highway 160 (south 4+180). "Union Pacific's Eastern Tracks" refer to the railroad tracks just downstream of Highway Business 80 which are about 1.6 miles upstream of the "Western Tracks" (north 7+376 & south 6+533.

1.1 SITE (OR SECTION)R2 NORTHERN CROSSING OF UNION PACIFIC'S EASTERN TRACKS PLUS UTILITIES (7+338 TO 7+410)

This northern crossing (R2)is on the same track alignment as the southern crossing (L4) paragraph 1.4. The other requirements of the southern crossing shall also apply to this northern crossing. The contractor shall determine schedule and equipment for performing work in a timely manner.

1.1.1 Daily Time Limit

Due to the critical nature of railroad operation, as well as for safety reasons, the Contractor shall notify Union Pacific Railroad(UPRR), Manager of Track Maintenance, a minimum of 10 days in advance of any construction on, along, or across the right of way or tracks. The Manager of Track Maintenance has changed from the person indicated in attachment 3, titled Maintenance Consent Letter. The POC is now Mr. Blaine Peterson (916)789-5311 and not Kevin McQuitty. Paragraph 1.1.5 provides requirements for work within the track zones indicated.

1.1.2 Staging Area

The government has procured staging area 7+350 which is a triangular area bordering tracks and the levee as shown on sheet 1034-C-17. This area serves the work at reach R2. There are buried fiberoptic cables and liquid petroleum pipeline running in a generally north-south direction and marked on the ground. The Contractor shall place steel trench plating over the pipeline at areas where construction equipment will pass or park or where fill in excess of 0.7 meters will be placed, to provide additional protection for the pipe over and above the existing protective fill. The plating shall be a minimum of five-eights inch thick steel and span a minimum of 4 feet to each side of the petroleum pipeline. Fill shall be graded under the plates in a manner to evenly distribute loading. No excavation shall occur in the staging area. The Contractor is responsible to protect-in-place these and all existing utilities. See SECTION 1034-02000 MOBILIZATION AND DEMOBILIZATION of these specifications regarding clearing and regrading. See 02730-1.3.4.

1.1.3 Access to Staging Area

The access to the staging area, along the landside toe, as shown on sheets C-16.1, C-16.2 and C-17 narrows between the railroad tracks and the levee near the eastern end of this toe road. The eastern most portion of this access road narrows. To facilitate access and egress of equipment, the Contractor shall fill and regrade the narrow portions as shown on sheet C-19.1 and as described in SECTION 1034-02000 MOBILIZATION AND DEMOBILIZATION of these specifications.

Between the tracks and the public street, the Contractor shall stay on the asphalt road only. The land off the asphalt is private and traspass is prohibited. Access is shared with the City O&M as well as the public. Drivers shall proceed slowly and with care. A flagperson shall be stationed in the zone between the ramp up the levee and the public street as shown on sheet C-19.1.

1.1.4 Permits

Attachment 3 at the end of this section contain a Contractor's Right of Entry Agreement which follows a Maintenance Consent Letter. As per the instructions associated with the permits, the Contractor shall prepare required information, pay all required fees and obtain and abide with all required permits.

A haul road crossing permit shall be obtained as required by SECTION 01500 PROTECTION AND MAINTENANCE OF VEHICULAR, BIKE AND PEDESTRIAN TRAFFIC paragraph 1.5.5 "Construction Access Crossing Railroad Tracks".

As per the instructions associated with the permits, the Contractor shall prepare required information, pay all required fees and obtain and abide with all required permits.

1.1.5 Track Zone

Track zones are based upon distances from the centerline of railroad tracks. There are different requirements when working in different zones.

1.1.5.1 Zone 1

Zone 1 is defined as work within 2.6 meters(8.5 ft) either side of the centerline of the tracks. Trains must be stopped prior to work commencing in this zone. Clearance to work within this track zone shall be requested and approved in advance of any work commencing. UPRR will modify the Contractor request as required to accommodate UPRR operations for the track in question. This modification may include denying any Contractor work in the track zone for the time(s) requested. The Contractor will not receive clearance from UPRR until the week prior to the work commencing. A flag person is required for work within this zone (see paragraph 1.1.6). The flag person communicates with the train dispatcher to stop trains approximately 2 miles from the construction site. For bidding purposes the work in Zone 1 shall be assumed to occur only on Mondays for a maximum time interval of 4 hours and on Sundays for a maximum time interval of 4 hours occurring either in the night or daylight.

1.1.5.2 Zone 2

Zone 2 is defined as work within the strip either side of the tracks between 2.6 meters(8.5 ft) and 7.6 meters(25 ft) from the centerline of the tracks. Trains are not required to be stopped for work proceeding in this zone. Clearance to work within this track zone shall be requested of UPRR and approved in advance of any work commencing. UPRR Form B procedures shall be in effect in this zone. A flag person is required for work within this zone (see paragraph 1.1.6). The flag person communicates with the train dispatcher to slow trains down that enter the construction site. All personnel will be required to be at least 7.6 meters(25 ft) from the centerline of tracks while the train passes through the area. Equipment etc., exclusive of personnel, may remain in place in the zone while the train passes through the construction site. Personnel may return to the equipment after the train passes.

1.1.5.3 Zone 3

Zone 3 is the area outside of zone 1 and zone 2. Zone 3 is defined as the area either side of the tracks greater than 7.6 meters(25 ft) from the centerline of the tracks. Trains are not required to be stopped for work proceeding in this zone. Clearance to work within this track zone shall be requested of UPRR and approved in advance of any work commencing. A flag person is not required for work within this zone.

1.1.6 Flag Person

A railroad mainline crossing is required by the work. The Contractor shall contact Mr. Terry Minarik, Union Pacific Railroad Company, at (402) 997-3587 to obtain a Haul Road Crossing Application. The processing fee is $550. A copy may also be obtained on the Internet at www.UPRR.com

(http://www.uprr.com). The Haul Road Agreement takes 30 days to process. Late request for expedited service cannot be accommodated. The Contractor shall submit a completed application to Mr. Terry Minarik in a timely manner as to account for processing time.

Mr. Terry Minarik
UPRC
1800 Farnam Street
Omaha, Nebraska 68102

The executed Haul Road Crossing Agreement will contain a flag person provision. The Contractor must give Jim Smith, (916) 789-6352 a five day written and confirmed notice to arrange for a Union Pacific Railroad flag person. The Contractor is responsible for the cost of the UPRC flag person at $350 per day.

The flag person shall be present during all operations crossing at this location and for work within the track zones indicated in paragraph 1.1.5. The Contractor shall cross the tracks with rubber tired vehicles, however a temporary crossing is required. For track mounted equipment, a temporary crossing is required.. No metal parts are allowed to come in contact with the railroad tracks. Any crossing or work in the proximity of these tracks shall be coordinated with Jim Smith at (916) 789-6352 and Mr. Terry Minarik at (402) 997-3587.

The permit application shall be submitted within 3 calendar days from the notice to proceed. The permit shall be obtained within 33 calendar days after the notice to proceed. Delays due to Union Pacific not responding within 30 days shall be immediately reported to the Contracting Officer.

1.1.7 Precast Concrete Panels

The replacement of the asphalt concrete track crossing shall be coordinated with and to the satisfaction of the Union Pacific Railroad(UPRR). The crossing shall be replaced with precast concrete panels. The Contractor shall contact Mr. Blaine Peterson, UPRR at (916)789-5311. For layout of precast concrete panels see attachment 3.

1.1.8 Temporary Crossing of UPRR Tracks

A temporary crossing will be required for UPRR tracks. The Contractor shall submit for approval, the design for the temporary crossing which shall be provided by the Contractor. This shall include plan and section views, dimensions, materials, hardware and method of attachment. Such design shall be submitted at least 30 calendar days prior to construction.
For bidding purposes see the Rail Protection Detail on sheet C-27. For those locations where there are double tracks, the single track detail shown on sheet C-27 shall be modified for the double track crossings.

1.1.9 Equipment Information

Upon first contact with the UPRR with regard to the temporary crossing, the Contractor shall provide equipment specifications for equipment which will work on or pass over the UPRR tracks. These specifications will include a

list of all equipment and vehicles and include dimensions and weight including approximate axial weights and type of tracking (i.e. pneumatic or steel track) and any other information which may affect rail tracks.

1.1.10 Ballast

Should the grouting operation cause infiltration of the ballast, any hardened cement grout in the ballast shall be replaced with new ballast material. The Contractor shall replace the ballast as indicated in SECTION: LEVEE RESTORATION, EARTHWORK AND ROADWORK, paragraph 2.5 for ballast material and paragraph 3.10 for placement.

1.2 SITE (OR SECTION)L2 SOUTHERN CROSSING OF HIGHWAY 160, LIGHT RAIL PLUS UTILITIES 3+608 TO 3+693

1.2.1 Daily Time Limit

1.2.1.1 Light Rail

The government has eliminated all jet grout injection locations on and within 3.1 meters(10 feet) of the Light Rail track centerline. Work performed more than 3.1 meters(10 feet) from track centerline may be performed daily without limitation, however, a Track Warrant is required. Light Rail has modified the Track Warrant Condition #1, that personnel and equipment be at least 10 feet from the nearest rail, to allow personnel and equipment no closer than 10 feet from track centerline.

The Contractor shall obtain a Track Warrant and/or Red Tag (see paragraph 1.2.7) for each and every shift of Limited or Full Access construction, as defined below. Limited access construction is defined as work to be performed from 1.8 meters(6 ft) to 3.1 meters(10 ft) of the centerline of the track. This work may be performed daily, approximately 12:45AM to 4:15AM.

Full access construction is defined as work occuring on the existing track and within 1.8 meters of the centerline of the tracks. A Red Tag is required. The Contractor shall obtain a Red Tag a minimum of 10 days prior to commencing full access construction. A separate Red Tag is required for each shift. Construction for the sump pit and cleanout shall utilize equipment which will operate beneath the minimum 3.1 meter (10-foot) clearance zone around the 900 volt DC powerline. For this condition, work can be performed daily, approximately 12:45AM to 4:15AM. See also the attached "Contractor Safety Information" sheets of the Sacramento Regional Transit District which follow this section and paragraph 1.2.7.

1.2.1.2 Caltrans

The time for working on any lane of the roadway is limited as per the attached California Department of Transportation encroachment permit.

1.2.2 Staging Area

The government has procured staging area 3+650 which is an area in the median between the east and west bound lanes, and area 3+520 which is at the end of a private street which abuts the levee. These areas are shown on sheets 1034-C-4 and 1034-C-3.1 respectively.

1.2.3 Permits

Attachment 1 at the end of this section contain the following dealing with the State of California, Department of Transportation (Caltrans): Encroachment Permit, Lane Closure Chart, Traffic Control System Standard Plans, and Definitions.

Attachment 4 contains the Sacramento Regional Transit District: Contractor Safety Instructions and other associated information.

The Contractor shall obtain and submit the latest versions of permit forms. As per the instructions associated with the permits, the Contractor shall prepare required information, pay all required fees and obtain and abide with all the provisions, requirements and stipulations of the above and all required permits.

Caltrans encroachment permits may also be available at: http://www.dot.ca.gov/hq/traffops/developserv/permits/applications/

1.2.4 Traffic Control, Stipulations and Considerations for Work on Highway 160

This paragraph (1.2) describes special provisions for Highway 160 construction operations. These shall be considered and incorporated as appropriate by the Contractor in preparing the Traffic Control Plan (see SECTIONS 01500-1.5 and 01505-1.4 and 1.24). Prior to start of construction on the Highway, the Contractor shall contact the appropriate people as shown on sheets 1034-U-1 and 1034-U-2.

The Contractor shall also notify the following of any disruption of normal traffic. This requirement is in addition to any other notification requirements cited in these plans and specification such as sheets 1034-U-1 and 1034-U-2.

Sacramento City Police (within City limits) (24 hours)	(916) 264-5471
Sacramento County Sheriff (outside City limits) (24 hours)	(916) 874-5115
Sacramento City Fire Marshall (M-F/8 a.m. - 5 p.m.)	(916) 264-5266
California Highway Patrol	(916) 263-3550 (day) (916) 445-2211 (24 hour dispatch)

The Contractor shall place signs, facing approaching traffic in order to safely direct traffic. During work, a "K" rail or equivalent physical barrier shall be placed between the lane and the Contractor's work area. In the event there is a conflict between the requirements of the Caltrans permit and these specifications, the more stringent shall apply as determined by the Contracting Officer.

Construction Operation Traffic Circulation: For construction at this site, the Contractor shall use only haul roads as shown on sheet C-3.1 and C-4. Any modification or additional haul roads shall be approved by the Contracting Officer.

1.2.5 Utilities

The utilities crossing the jet grout wall as shown on sheet 1034-U-2 and as indicated in specification section 1034-02730 shall be protected-in-place. An exception are the irrigation lines which may, at the Contractor's option, be cut and temporarily by-passed during the jet grouting work. If by-pass is done, irrigation unavailability shall never exceed 72 hours from October 15 through March 15 or 12 hours from March 16 through October 14.

If utilities are under the pavement as determined by Underground Service Alert markings or direct notification, particular care and hand excavation shall be utilized in the vicinity of the utilities, to safely expose such utilities during the excavation of the trench as shown on sheet C-21 and described on sheet U-2 and specification section 02333. The cut through the pavement shall be sawcut clean and vertical.

The trench shall not be excavated earlier than 4 days prior to drilling or grouting. Repaving shall not occur more than 3 days following, notification by the Contracting Officer that the grout cuttings are adequately cured. See sheet 1034-C-21 note 3 regarding minimum time. Steel plates intended for such use shall cover all trenches except while actively drilling or grouting at the immediate area. Signs and barricades with flashing lights shall warn drivers of the work or the covered trenches at all times. The road adjacent to the excavation shall be kept clean to avoid creating a skid hazard. See also specification 1034-02333-3.9 and 1034-C-21.

1.2.6 Equipment Information

1.2.7 Stipulations and Considerations for Work on and near Light Rail Tracks

1.2.7.1 Temporary Relocation of Overhead Lines

The Relocation of the signal cable will be accomplished by Regional Transit forces contracted separately by the government. Regional Transit will not disconnect the line but will attach it to a temporary pole. The signal

cable includes both communication and 240 volt AC lines. The temporary pole shall be installed by the contractor. It shall be located no closer than 10 feet from the contractor's drill rig and approximately centered between the cable supports on either side of the jet grout location. The pole shall extend a minimum of 30 feet above ground and an additional 10 feet into the ground. Regional Transit shall be contacted a minimum of 7 days in advance of signal cable relocation and pole location coordinated at that time. Regional Transit will utilize a tie back that forms a 'Y' connecting to the cable at two points approximately 12 feet apart and connecting the remaining leg to the pole. Upon completion of the jet grouting, Regional Transit shall be contacted to place the cable in its original location. Seven (7) day notice is required. The contractor is responsible for removal of the temporary pole including backfill and disposal of the pole. The contractor may leave the signal cable in place if a minimum of 1 foot clearance from the side and bottom of the cable can be maintained at all times to any portion of the contractor's equipment. THE 900 VDC LINE is located above track centerline and shall remain active.

1.2.7.2 Temporary Crossing

1.2.7.3 Surveillance of Drain Line

The Contractor shall perform surveillance of the four (4)inch diameter drain line parallel to tracks, by installing a pipe cleanout 3 meters up grade of the jet grouting. The train overhead power line will not be shutoff. All excavation to install this cleanout shall occur at a time when no trains are scheduled. No open excavation shall exist adjacent to the tracks from one hour prior to the first morning train to the last train of the day. All material removed to access this drain shall be completely replaced and compacted in the existing manner and configuration a minimum of one hour prior to the next scheduled train passing. Pre-construction survey using video camera shall be performed 15 meters(50 feet) upstream and downstream of the pipe cleanout. Water shall be introduced near the drain during the pre-construction survey and water emerging into the drain shall be observed by the camera. A sump pit shall be installed 4 meters down grade of the jet grouting shown on sheet C-22. The connection to the pit and the existing 4 inch diameter drain pipe shall be made using a pipe 6 inches or greater in diameter. The sump pit shall be located no closer than 3.1 meters(10 feet) from the nearest rail. Details of the connection and construction of the sump pit and cleanout shall be submitted to the Contracting Officer at least 30 days prior to construction for approval. During the jet grouting shown on sheet C-22, the drain shall be monitored with video camera. The video camera shall be located within one meter of the cleanout. If during jet grouting the flow of cuttings is observed, the jet grouting shall stop immediately and corrective action shall be taken immediately to prevent further migration into the ballast. Upon completion of jet grouting, the contractor shall restore the 4 inch diameter drain pipe and surrounding area to its original condition.

1.2.7.4 Ballast

Should the grouting operation cause infiltration of the ballast, any

hardened cement grout in the ballast shall be replaced with new ballast material. The Contractor shall replace the ballast as indicated in SECTION: LEVEE RESTORATION, EARTHWORK AND ROADWORK, paragraph 2.5 for ballast material and paragraph 3.10 for placement.

1.2.7.5 Track Warrant and Red Tag Requirements

Track Warrants and Red Tags shall be obtained by contacting Metro Control at (916)648-8415. The Contractor shall fill out and submit Light Rail Track Warrant and the Red Tag Form and submit to Regional Transit directly with a simultaneous copy to the Contracting Officer.

The Contractor shall obtain a Track Warrant for each and every work shift. Up to seven consecutive work days can be included on each Track Warrant form. Each day, however, requires a unique authorization number. Track Warrants must be submitted a minimum of 24 hours in advance of work commencing. See appendix 4 for "Track Warrant" and "Instructions for Track Warrants" for additional requirements and other pertinent information. The Contractor shall state in the "Light Rail Track Warrant" for trains to slow to 5 mph while passing over the work area during curing of jet grout bodies.

1.2.7.6 Work Plan

A Work Plan detailing actual anticipated hours of work, construction methods, and activities shall be submitted to the Regional Transit and the Contracting Officer for approval as per the "Contractor Safety Instructions" which follow this section in attachment 4.

1.2.7.7 Miscellaneous

No object shall extend more than 4" above the top of rail.

The Contractor and all of its subcontractors are responsible to undergo Worker Environmental Awareness Program (WEAP) training. This training takes approximately fifteen minutes and is provided by Regional Transit.

1.2.8 Costs of Dealing with Light Rail

1.2.8.1 Track Warrant Estimated Cost

The government has eliminated all jet grout injection locations on and within 3.1 meters(10 feet) of the Light Rail track centerline. If work requires trains to be stopped, the RT organization may suffer economic harm estimated at a cost of $8,000 TO $12,000 per week-end, even greater cost during the week or $3,500 per hour beyond specified work hours (estimates provided by RT and not validated by the Government). Bidders may wish to consult legal counsel as to their potential liability in this matter.

1.2.8.2 Limited Access Construction

Track Warrants for limited access construction, when Light Rail service is not disrupted, shall be issued without cost to the Contractor.

1.2.8.3 Full Access Construction

The initial Track Warrant for full access construction shall be accompanied with a service disruption(surity) bond in the amount of $50,000 naming Sacramento Regional Transit as beneficiary (see paragraph 1.2.8.1 for bond exposure).

1.2.8.4 Red Tag Fee

The fee for the "Red Tag Form" is Two Hundred Fifty Dollars ($250)per shift which the Contractor shall pay directly to the Regional Transit.

1.2.9 Employee Parking

There will be limited parking available to the Contractor's employees in the private parking lot southwest of staging area 3+520. There will be provisions and restrictions regarding which stalls are available, the type of vehicles permitted and other activity. The following shall be contacted at least 12 days prior to use or 3 days prior to a preconstruction walk through whichever is earlier:
Joe Michaelson (Cal Rec Board) 916 657 4331
or Cliff Winston (Cal Rec Board) 916 653 5361
and Scott Cowan (Mgr. Western Truck Parts and Equipment) 916 441 6151

1.3 SITE (OR SECTION)L3 SOUTHERN CROSSING OF UNION PACIFIC'S WESTERN TRACKS PLUS UTILITIES (4+167 TO 4+213)

1.3.1 Daily Time Limit see paragraph 1.1.1. The contractor shall determine schedule and equipment for performing work in a timely manner.

1.3.2 Staging Area

The government has procured staging areas 4+100 as shown on sheet C-7.

1.3.3 Permits

Attachment 3 at the end of this section contain: a certificate of insurance, a Contractor's Right of Entry Agreement, and a Maintenance Consent Letter.

A haul road crossing permit shall be obtained as required by SECTION 01500 PROTECTION AND MAINTENANCE OF VEHICULAR, BIKE AND PEDESTRIAN TRAFFIC paragraph 1.5.5 "Construction Access Crossing Railroad Tracks".

As per the instructions associated with the permits, the Contractor shall

prepare required information, pay all required fees and obtain and abide with all required permits.

1.3.4 Track Zone

Reference paragraph 1.1.5 regarding the definition of, and special requirements for work in the track zone.

1.3.5 Flag person see paragraph 1.1.6

1.3.6 Temporary Crossing of UPRR Tracks

See paragraph 1.1.8.

1.3.7 Equipment Information

See paragraph 1.1.9.

1.3.8 Ballast

See paragraph 1.1.10.

1.4 SITE (OR SECTION)L4 SOUTHERN CROSSING OF UNION PACIFIC'S EASTERN TRACKS PLUS UTILITIES (6+501 TO 6+550)

This southern crossing (L4)is on the same track alignment as the northern crossing (R2) paragraph 1.1. The other requirements of the northern crossing shall also apply to this southern crossing. The contractor shall determine schedule and equipment for performing work in a timely manner.

1.4.1 Daily Time Limit see paragraph 1.1.1

1.4.2 Staging Area

The government has procured staging area 6+700 as shown on sheet C-11. No excavation shall occur in the staging areas.

1.4.3 Permits

Attachment 3 at the end of this section contain: a certificate of insurance, a Contractor's Right of Entry Agreement, and a Maintenance Consent Letter.

A haul road crossing permit shall be obtained as required by SECTION 01500 PROTECTION AND MAINTENANCE OF VEHICULAR, BIKE AND PEDESTRIAN TRAFFIC paragraph 1.5.5 "Construction Access Crossing Railroad Tracks".

As per the instructions associated with the permits, the Contractor shall prepare required information, pay all required fees and obtain and abide with all required permits.

1.4.4 Access

Access to this site may be made from the waterside passing below the railroad bridge as shown on sheet 1034-C-10 if all vehicles and equipment can safely clear the bridge and access occurs 16April to 31October. If access occurs outside this time period, the Contractor shall have secured all permits required to pass over the railroad tracks as described in this paragraph. The Contracting Officer retains the right, without an increase in contract cost, to stop access under the bridge if he or she deems that such access poses a danger to the structure, or equipment driver. As per 1034-02730-1.3.2 The Contractor is responsible for any damage to the bridge or any other public or private facility.

1.4.5 Track Zone

Reference paragraph 1.1.5 regarding the definition of, and special requirements for work in the track zone.

1.4.6 Flag person see paragraph 1.1.6

1.4.7 Temporary Crossing of UPRR Tracks

See paragraph 1.1.8.

1.4.8 Equipment Information

See paragraph 1.1.9.

1.4.9 Ballast

See paragraph 1.1.10.

1.5 SITE (OR SECTION)L4A 24" SEWER @ 6+608 TO 6+638

This is a County owned sewer pipe buried in the levee. See sheet 1034-U-2. The interior of the pipe shall be videotaped during the active jet grouting which will have contact with the pipe.

1.5.1 Videotaping Pipe Interior

The Contractor shall arrange to videotape the interior of this sewer for the purpose of establishing that exterior grouting has not breached the walls or joints of the pipe and to take immediate measures should such be observed during grouting.

The camera shall be submersible and mounted on a crawler. There shall be a monitor installed in a vehicle from which real time observation may take place and simultaneously recorded on tape. Resolution shall be such that a leak of grout material into the pipe will be noticed immediately. View shall cover the entire internal circumference either simultaneously or by

remote control from the surface. All equipment shall be of the type typically used by plumbers. The Contractor shall supply the Contracting Officer with the original videotape on either a VHS or CD format within 24 hours following the work.

The Contractor shall arrange with the County point of contact to access the pipe through an air valve.

1.6 NORTH BANK ABANDONED PIPE BROKEN AT CENTER TO BE FILLED WITH CONCRETE 14+180

During placement of the slurry wall, an abandoned 12" diameter steel cylinder concrete encased pipe was broken by the excavator due to mislocation. Soil-cement-bentonite backfill was placed and is now assumed to have taken a configuration as shown on sheets 1034-U-4 and 1034-U-5.

The Contractor shall completely fill the two remaining segments by pumping each segment with Controlled Low Strength Material as follows:

Controlled low strength material (CLSM) shall be as defined in ACI 229R and shall consist of lean slurry of Type II Portland cement blended with size number 8 coarse rounded aggregate conforming to the requirements specified in ASTM C 33. The Contractor may elect to increase the flow-ability by using fly ash as the aggregate filler. CLSM shall have a 28-day compressive strength between when tested in accordance with ASTM D 4832. CLSM shall have a hydraulic conductivity of or less when tested in accordance with ASTM D 5094 for 28-day aged samples.

10 days prior to placement, the Contractor shall submit a certification of CLSM. This certification shall state that testing has concluded that the material to be placed is in conformance with the requirements of this paragraph. During pumping of material, the Contracting Officer shall be entitled to take a maximum of 0.03 cubic meters(one cubic foot) of material from the batch as a testing sample at no additional cost.

1.7 MEASUREMENT AND PAYMENT

There shall be no measurement made for the purpose of payment for the work described in this section. Payment for the work required by this section, except for sites L4 and L4A, shall be included in the lump sum price for the individual section (site) for which the work is done. Such price schedule items are as follows:

"SITE L2 MOBILIZATION AND DEMOBILIZATION INCLUDING FENCING"
(See paragraph: 1.2.8 "Costs of Dealing with Light Rail" for issues which may affect payment for site L2).

"SITE L3 MOBILIZATION AND DEMOBILIZATION INCLUDING FENCING"
"SITE R2 MOBILIZATION AND DEMOBILIZATION INCLUDING FENCING"
"FILL TWO HOLLOW SECTIONS OF BROKEN PIPE AT 14+180"

The costs for sites L4 and L4A shall be included in the pricing schedule item under specification 1189: "MOBILIZATION AND DEMOBILIZATION INCLUDING FENCING" which shall include all the required work. See Specification 1189 Section 02000 .

The bid items shall include the complete cost of work specified in Sections 1034-02000 and 1189-02000 "MOBILIZATION AND DEMOBILIZATION" as well as all work required by other sections of this contract as specified from such other sections to be included in these price schedule items.

1.8 SUBMITTALS

Government approval is required for all submittals with a "G" designation; submittals not having a designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan

Light Rail Track Warrant

Red Tag Form

the design for the temporary railroad crossing

Details of the connection and construction of the sump pit and cleanout

SD-07 Certificates

A copy of every document

original videotape

certification of CLSM

SD-03 Product Data

equipment specifications

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02332

JET GROUT CUTOFF WALL

-- End of Section Table of Contents --

SECTION 02332

JET GROUT CUTOFF WALL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PETROLEUM INSTITUTE (API) STANDARD SPECIFICATIONS

API SPEC 13A	(1993; 15th Ed.) Specification for Drilling-Fluid Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 109/C 109M	(1999) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1994) Standard Specification for Portland Cement
ASTM D 698	(2000a) Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
ASTM D 3740	(1996) Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 1556	(1990) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2487	(1993) Test Method for Classification of Soils for Engineering Purposes
ASTM D 4832	(1995) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D 5084	(1990) Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM E 329	(1990) Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction

U.S. ARMY CORPS OF ENGINEERS

EM 385-1-1	(1996) Safety and Health Requirements Manual

1.2 SCOPE

The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, materials, and of performing all operations in connection with the construction of the jet grout cutoff walls in accordance with these specifications and applicable drawings.

The jet grout cutoff wall shall be predominantly constructed using a single row (primary line) of triple fluid jet grout columns. For each jet grout drill hole a drilling deviation measurement shall be performed prior to any jet grouting. Drill deviations shall be performed on each core hole and rotary exploratory holes. A limited amount of secondary jet grout treatment shall be performed as defined in paragraph 1.4.7.

Jet grouting shall be utilized across buried utilities that are to be protected inplace, three railroad crossings, one light rail crossing, and across State Highway 160. The work shall commence after the Jet Grout Test Section is completed.

1.3 GEOTECHNICAL SITE CONDITIONS

1.3.1 Explorations

Subsurface explorations have been obtained by the Government and are included in the contract documents. Logs of explorations are shown on contract drawing sheets B-4 through B-18. Additional explorations were performed in December 1999 and January 2000. Observation wells were installed in December 1999. This information can be found in "Geotechnical Data Report for Deep Cutoff Wall Section" referenced in SECTION 02020, SUBSURFACE DATA.

Difficult drilling conditions and zones of gravel and cobbles are discussed in SECTION 02020, SUBSURFACE DATA. Bulk samples of the gravel and cobble zone have been obtained during the slurry cutoff wall construction, refer to SECTION 02020, SUBSURFACE DATA. The groundwater levels indicated on the logs of explorations are at the time of drilling and will vary depending on time of year and river stage. Refer to SECTION 02020, SUBSURFACE DATA for

more information regarding subsurface conditions.

1.3.2 Contractor's Responsibility

It is the Contractor's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials by inspecting the sites and by evaluating information derived from available exploratory work and the explorations that are required as part of this contract. For more information on Contractor's responsibility refer to SECTION 02020, SUBSURFACE DATA. It is required that the Contractor locate existing utilities through excavation, probing or other suitable methods prior to jet grouting. For more information refer to SECTION 02730, UTITLITES.

1.3.3 Modifications to the Jet Grout Cutoff Wall Depth

The Contracting Officer may at any time prior to or during construction require a change in the depth of the jet grout cutoff wall. The objective of the jet grout cutoff wall is to block potential seepage through sands, gravel, and cobbles, and other pervious zones in embankments and their foundations. The effectiveness and optimization of the cutoff wall may require increasing or decreasing the depth of the cutoff. The potential variation from the depth indicated in the plans is estimated to be plus or minus 1.5 meters (5 feet), however all equipment shall be capable of jet grouting, coring, and performing rotary exploratory drilling to depths up to 30 meters (100 feet).

1.4 DEFINITIONS

The terms used in this section are defined as follows:

1.4.1 Jet Grout Panel

A panel of grout slurry mixed with some resultant soil particles not removed by an erosive composite water/air jet. The panel is formed by jetting mono-directional and lifting the jetting rods, however some movement of the jet grout rods moving in an arc of about 20 degrees may be required at some panels (i.e. Regional Transit Light Rail site).

1.4.2 Jet Grout Partial Column ~~Option~~

A partial column of grout slurry mixed with some resultant soil particles not removed by an erosive composite water/air jet. The partial column is formed by jetting in an arc of about 120 degrees while incrementally lifting the jetting rod. The partial column is installed in-line with the drill hole of the column center, shown on sheet C-25. The drill hole spacing between adjacent partial columns is also shown on sheet C-25. The sweeping motion of the partial column is used to fill in any potential gaps between adjacent columns on the primary line and create a more uniform cutoff wall. The partial column may be installed over a selective depth of treatment (i.e. gravel and or cobble layers and or below the ground water table). The Contractor shall demonstrate this method in the Jet Grout Test Section of this contract. ~~This option may be used for the production work~~

~~based upon execution by the Government.~~

1.4.2.1 ~~Jet Grout Partial Column Alternate Option~~

~~As an alternative to the definition in paragraph 1.4.2, the overlap between adjacent primary columns can be filled-in by a jet grout method selected by the Contractor as long as the effective zone of treatment for the partial column alternative shall result in a plan area equivalent to the crossed hatched area shown on sheet C-25. The partial column alternate option may be installed over a selective depth of treatment (i.e. gravel and or cobble layers and or below the ground water table). This option may be used based upon execution by the Government.~~

1.4.3 Drilling Deviation Measurements

Drilling deviation measurements are performed using an instrument capable of biaxial measurements to determine the magnitude of all borehole deviations. The biaxial instrument for measuring the drilling deviations of the jet grout hole shall be able to fit inside the triple fluid jet rods or be attached to the bottom of the rods. The biaxial inclinometer for all the coreholes and rotary exploratory boreholes shall be able to fit along the entire length of a minimum 102-millimeter (4-inch) diameter hole.

1.4.4 Jet Grouting

Jet grouting, as defined in this specification, shall consist exclusively of a triple fluid system, in which the jet rods are designed to inject three different fluids; air, high pressure water and pressurized cement grout through jets. This process excavates soil using an air/water jets and grout injection using a jet located below the point where the air/water jet is located. The triple fluid jet rod is slowly rotated and incrementally lifted at a constant incremental speed to achieve thorough mixing and a consistent continuous cylindrical column. This triple fluid jet grouting process will be used to form a primary line of full cylindrical overlapping jet grout columns. Mono-directional triple fluid injection shall be used to form a primary line of panels at a few select railroad crossings.

Measurements and tests obtained during the installation of the primary line will be used to assess the need for a secondary jet grout treatment of triple fluid jet grouting. The secondary jet grout treatment will be installed at the direction of the Contracting Officer, and may require installation of 1) full cylindrical columns, or 2) partial columns ~~(if option is executed by Government)~~, as described in paragraph 1.4.2, for treating the overlap between adjacent primary line of columns.

1.4.5 Jet Grouting Specialist

The Contractor or their sub-Contractor shall have a jet grouting specialist with at least 3 years continuous experience in the last 5 years in triple fluid jet grouting on projects of similar scope and magnitude. This individual shall be on site for the entire project and shall be in

technical control of the project. The jet grouting specialist shall be knowledgeable in all aspects of jet grouting including but not limited to (1) control and monitoring of grout placement; (2) mixing methods required to properly mix grout; (3) a thorough knowledge of construction equipment, (4) air pressure and water volume control, and (5) quality control testing required for the jet grout cutoff wall construction.

1.4.6 Primary Line Jet Grout Columns

A series of overlapping nearly cylindrical columns of cement grout slurry mixed with some resultant soil particles not removed by an erosive composite water/air jet. The intent of the primary line of jet grout columns is to form a continuous cutoff wall.

1.4.7 Secondary Line of Jet Grout Treatment

There are three conditions where a secondary line of jet grout treatment shall be constructed:

1. A selected number of full cylindrical or partial columns (if option is executed) may be used as determined by the Contracting Officer, including required depth of treatment. All full cylindrical secondary columns shall be constructed using the same jetting parameters as the adjacent primary columns.

2. A secondary line of full cylindrical jet grout columns shall be installed to the depth interval as the primary line to form a three column overlap pattern in order to perform in-situ water pressure testing (two primary line columns and one secondary line column).

3. In each of the traffic lanes on State Highway 160 a secondary line of overlapping full cylindrical columns shall be constructed using the same jet grouting parameters as the primary line and to the same depth interval as the primary line.

The following estimates are intended to prorovide a more uniform basis for developing costs for the three conditions listed for the secondary line of jet grout treatment.

Secondary Line of Jet Grout Treatment, Full Cylindrical Column:

The following percentages are estimated. Traffic lanes across State Highway 160 at the same depth interval as the primary line represents approximately 65 percent of the area (about 900 square meters) listed in the estimated quantity for subdivided item A. The remaining 35 percent of the area (about 500 square meters) listed in the estimated quantity for subdivided item A is for the columns to perform for the in-situ water pressure tests which are at the same depth interval as the primary line of jet grout treatment. The area for the columns is estimated to be distributed over the sites as follows: 20 percent for Site L2, 30 percent for Site L3, 20 percent for Site L4, 10 percent for Site L4A, and 20 percent for Site R2. Similarly, quantities used for subdivided item B as needed are estimated to be distributed over the sites as follows: 20 percent for Site L2, 30 percent for Site L3, 20 percent for Site L4, 10

percent for Site L4A, and 20 percent for Site R2. The depth of treatment is estimated to be at the same depth interval as the primary line of jet grout treatment.

Secondary Line of Jet Grout Treatment, Partial Column:

It is estimated that the most likely zones or depth intervals where secondary line of jet grout treatment would be needed is the gravel - cobble zone. The percent of the area listed in the estimated quantity for subdivided item A is be distributed over the sites as follows: 20 percent for Site L2 for a depth interval of about 6 meters starting near the bottom of the primary line of treatment, 30 percent for Site L3 for depth interval of about 6 meters starting near the bottom of the primary line of treatment, 40 percent for Site L4 for a depth interval of about 9.5 meters starting near the bottom of the primary line of treatment, 10 percent for Site L4A for a depth interval of about 6 meters starting near the bottom of the primary line of treatment, and no treatment is anticipated for Site R2. Similarly, quantities used for subdivided item B as needed are estimated to be distributed over the sites using the same distribution for subdivided item A.

1.4.8 Jet Grout Operator

Individuals with at least 3 years experience in the past 5 years in the operation and maintenance of jet grouting rods, grouting plants, and high pressure pumping equipment required to perform triple fluid jet grouting.

1.4.9 Slotted Steel Casing and Lexan Liner Option

As part of the field QC/QA procedure a slotted steel casing with Lexan liner may be fabricated and installed at selected locations determined by the Contracting Officer. The use of this option will be determined by the Contracting Officer. The purpose of the slotted steel casing with Lexan liner is to allow a borehole camera to be placed inside of a Lexan liner which protects the camera against damage from the jet grout. The camera is then lowered inside of the Lexan until the camera is at a slot in the steel casing. The camera will then be used to detect the arrival of the jet in the view finder of the camera. As the jet grouting continues the camera is lifted to the next viewing point to repeat the detection of the jet grout against the Lexan. The steel casing will be encapsulated by jet grout columns placed on each side of the slotted steel casing.

After a sufficient curing period the Lexan inside of the pipe will be reamed out for purposes of performing a water pressure packer test from inside of the slotted steel casing. The open slots on the steel casing will allow water to permeate into the soil-cement of the jet grout column.

1.4.10 Borehole Camera

The borehole camera shall be used in conjunction with cored bore holes or rotary exploratory holes in the jet grout cutoff wall, or with a slotted steel casing and Lexan liner (if option is executed). The borehole camera

shall be capable of fitting inside of all holes drilled through the jet grout cutoff wall and any steel Lexan lined casing used. The camera shall also be capable of viewing the sidewalls of all holes along the entire length of the hole.

1.4.11 Borehole Camera Specialist

Individuals with at least 3 years experience in the past 5 years in the operation and maintenance of borehole cameras and field operated video taping equipment.

1.4.12 Jet Grout Cutoff Wall

The jet grout cutoff wall is a seepage barrier consisting of a primary line of jet grout columns, and a secondary line (see paragraph 1.4.7, "Secondary Line of Jet Grout Treatment) constructed by using triple fluid jet grouting techniques. The jet grout cutoff wall at the Regional Transit Light Rail site (Section L2) is a composite jet grout column and jet grout panel treatment, as shown on contract drawing sheet C-22. The approximate lineal extent is shown in plan on the contract drawings, and the approximate vertical extent is shown in profile between the designated top and bottom of jet grout cutoff.

1.4.13 Jet Grout Cutoff Wall Cover

The cover is a zone of compacted impervious fill and/or approved jet grout cuttings placed between the top of the jet grout cutoff wall and the final grade to be restored prior to placement of any surface treatment such as asphalt wearing surfaces, or aggregate surface course where the levee crown or trench in the levee crown is excavated to facilitate the jet grouting operation.

1.4.14 Impervious Fill Material

Impervious fill material is defined in SECTION 02333, LEVEE RESTORATION, EARTHWORK, AND ROADWORK.

1.4.15 Working Surface

The working surface is defined as the surface from which the jet grout cutoff wall is constructed.

1.4.16 Top of Cutoff Wall Cover

The top of the jet grout cutoff wall cover shall correspond to the pre-construction ground surface elevation.

1.4.17 Rotary Exploratory Drilling

Rotary exploratory drilling (such as tri-cone Tungsten roller bit) shall be selected by the jetting grout contractor to produce a minimum 102-millimeter (4-inch) diameter borehole using only water or air as the drilling fluid. The borehole shall be able to accommodate the borehole camera required in this specification.

1.4.18 Triple Fluid Jetting Monitor

The triple fluid jetting monitor is the rod appliance which holds the water, air, and cement jets.

1.5 SUBMITTALS

Government approval is required for all submittals with a "G" designation; submittals not having a designation are for information only. Submittals shall be sent to the Government no earlier than the completion of the five tests in Phase 1 of the Jet Grout Test Section, but at least 40 days prior to commencement of any mobilization of jet grouting equipment for production work except where noted otherwise in this specification. The requirements in Paragraph 1.7, SCHEDULE shall control. For the cutoff walls at Sections L4 and L4A, this paragraph is applicable except submittals shall be sent at least 40 days prior to mobilizing onto the levee. The following shall be submitted in accordance with specification 1034/1189, SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Jet Grout Equipment; G

Submit data on all equipment to be used in the construction of the jet grout bodies and equipment to be used in the Contractor's construction quality control testing shall be included. Project case history data shall be presented to show that the proposed equipment is capable of performing the production work. The Contractor will comment on the capability of their equipment to form a 4 meter (13.1 feet) long triple fluid jet grout panel, and indicate the maximum length of panel their equipment can form, by providing previous case history evidence. They shall also comment on their equipment capabilities to form partial columns with a rod rotation to produce an arc angle of 120 degrees, and to form panels with a slight sweeping motion to produce an arc angle of 20 degrees or state the minimum sweep angle possible with their drill. Methods for drilling and supporting the boreholes shall be included, especially how the Contractor will drill the triple fluid jet rods through the gravel-cobble layer.

Instruments for Drilling Deviation Measurements

Submit data on all instruments to be used for drilling deviation measurements, including manufacturer's operating manual. In particular, Contractor will provide details concerning the operation and data reduction of the instruments used for measuring drilling deviations for the triple fluid jet rods. Contractor shall submit previous jobs in which instrumentation was used along with sample data collected from the project. Data comparing the triple fluid jet rods instrument with a standard inclinometer shall be provided.

Control and Disposal of Jet Grout Waste; G

For each of the production sites, the contractor shall submit a specific waste management plan for control and disposal of all jet grout waste. Contractor shall provide estimates of waste generation for each site. Contractor shall show the location and volume capacity of all temporary storage pits or containers along with proposed liners for in-ground temporary storage pits. Data on and use of diverters to control the movement of the cuttings shall be submitted. Methods of excavating and transporting jet grout waste from the site shall be included. Contractor shall specifically address how solid waste and liquid waste will be handled and disposed of off the site.

In-Situ Water Pressure Testing; G

Data on equipment and procedures used for conducting the in-situ water pressure testing. Data on equipment shall include the packer system, appliances for applying water pressure, all gages for pressure and flow rate, and data reduction methods and analyses.

Equipment and Procedures for Rotary Exploratory Drilling; G

Data on equipment and procedures used for performing the rotary exploratory drilling.

Equipment and Procedures to Obtain Samples; G

Data on equipment and procedures to obtain cutting samples and cored samples. Cored samples of cutoff wall (soil-cement) shall consist of a minimum 102-millimeter (4-inch) diameter cored samples of hardened soil-cement obtained in 1.5-meter (5-foot) long runs. Split inner tubes will be used for core removal. Coring system shall be equivalent to Christensen Products large diameter convertible coring system (146 millimeter by 102 millimeters or 5.75 inches by 4 inches). The cored hole sample locations and time of coring cured soil-cement will be determined by the Contracting Officer.

High Pressure Operating Safety Manual; G

The Contractor is responsible for site safety. The Contractor will establish safety protocols and provide safety training to all personnel on-site as related to operating and working within the vicinity of high pressure pumps, lines, valves, etc. As a minimum, the safety manual will contain names, telephone numbers and also manufacturers certificates related to safe operating pressures for all lines, valves, connections, blow-off valves and any other items which operate under high pressure (above 7 MPa; 1000 psi). The manual will contain pump pressure characteristics used for the project, including: pressure-flow-transmission setting curves for high pressure pump, and piston size. Manual will have the name, phone number, and off- site location of Contractor appointed high pressure safety officer. Each member of jet grout crew will sign the safety manual after receiving appropriate instruction. Submit safety manual at least 21 calendar days prior to commencement of any mobilization of jet grouting equipment for the production work. Any safety infractions

and or incidences, no matter the severity shall be kept as a log entry in the safety manual. A copy of the current manual shall be available on site for review by the Government Quality Assurance inspectors.

Contractor shall submit sketches and manufacturers operating manual on safety valves to control maximum pressure in jet grouting line.

Contractor shall submit details of how operators at the drill rig will keep in constant communication with the high pressure pump operator. Due to the sensitivity with injecting in a levee embankment, the Contractor will have a communication system which will not rely upon hand held devices, and has a high level of assurance that high pressure pumping can be stopped quickly (i.e. 10 seconds).

Due to the difficulty with keeping the site secured from pedestrian access and work on State Highway 160, the Contractor will develop a positive means for isolating all high pressure lines from inadvertent pedestrian access or injury, or releases on State Highway 160. Positive means of isolation may include: use of appropriately sized steel pipe and fittings; direct burial of the high pressure lines surrounded by barriers and signage; and insertion of high pressure hoses inside appropriately sized steel pipe. These isolation methods shall be used for high pressure pumping from the grout plant to the jet grout working area. High pressure hydraulic hoses certified by the manufacturer will only be allowed for use unprotected at the surface in the actual jet grout working area.

Plans of Action For Response Value; G

Submit within 30 calendar days after the Notice to Proceed for review generalized plans of action to be implemented in the event any Response Value, as specified in paragraph 3.3.5, "Displacement Response Values" is reached or the observations indicate the potential for blockage of the return cuttings or blowout of the embankment side slope. The generalized plans of action shall be positive measures by the Contractor to do any or all of the following that is or are applicable:

1. Stop jet grouting immediately.

2. Submit plan to proceed forward with jet grouting such that the 7-millimeter (0.25-inch) maximum displacement (lateral or vertical displacement) will not be exceeded.

3. Submit plan to proceed forward with jet grouting to eliminate any jets from blowing out the side slopes of the levee.

SD-04 Drawings

Layout of Jet Grout Equipment; G

The layout of operations for the jet grout cutoff wall construction shall include but is not limited to drawings for grout mixing equipment, injection equipment, pumps, hoses, high pressure steel hard lines or other hose protection appliances, waste areas, and the location of jet grouting

with respect to support equipment for each production site.

Shop Drawings for Slotted Steel Casing with Lexan Liner Option; G

If the option is executed, the Contractor shall submit shop drawings used to fabricate the slotted steel casing and Lexan liner within 28 calendar days from the notification of the option. Details concerning the 76-millimeter (3 inch) slots, connection between runs of pipe, and capability of the pipe joints to allow slots to be aligned for a 27.4-meter (90-foot) string shall be shown on the drawings.

The shop drawings shall also show the details of the seal between the inside diameter of the steel casing and Lexan liner inside of the steel casing.

Borehole Camera; G

As part of this submittal the Contractor shall show the detail drawings for the borehole camera for use inside the core holes as specified, and all rotary exploratory holes and Lexan liner option. Manufacturers data specification sheets shall be included in the submittal for review, in particular capabilities of the encoder to stamp video tapes in real time. Three copies of video tapes for all borehole camera surveys shall be submitted within 24 hours of performing the survey.

SD-07 Schedules

Schedule and Sequence of Operations; G

It shall be required to perform the jet grout test section in its entirety prior to commencement of the jet grout cutoff wall construction. The jet grout cutoff wall shall be first constructed at sites L4 and L4A which are adjacent to the jet grout test section site. The general work sequence and schedule submitted by the Contractor shall include, but are not limited to: mobilization and site preparation, coordination of work with UPRR and Regional Transit Light Rail and Caltrans, jet grout column layout and installation sequence, waste management and disposal, and site restoration.

SD-09 Reports

Quality Control Testing and Reports

Reports of inspections or tests, including data reduction of raw data, organization, and presentation of graphs and plots shall be included. Test methods used shall be identified and recorded along with test results. Quality Control test results shall be submitted within 24 hours of completion of tests. Daily recorded information shall include but is not limited to hard copy output and floppy disk containing digital record from each jet grouting column and any borehole surveys conducted during the shift. Digital record shall contain:

1. Summary page containing:

a) basic project information, date, length, hole identification

b) data on drilling operations including start and end time, drill rod and bit sizes, maximum depth, top of aquiclude, drilling method, any fluids, total hole deviation at the hole bottom.

c) grouting operations start and end time: top/bottom elevation of columns, average jetting parameters, total weight of dry materials injected, total volume of grout injected.

d) any observations during drilling and injecting, other pertinent observations such as grout escapes, ground heave, conformance to response values, or other unusual behavior.

2. Digital file for input into Microsoft Excel Spreadsheet containing the following data scanned continuously:

a) during drilling: clock time, depth, drilling rate, rotary speed, thrust on tool, rotary torque, drilling fluid pressure, specific energy.

b) during jet grouting: clock time, depth, incremental lift speed water pressure and flow rate, air pressure and flow rate, grout density/pressure/flow rate, and revolutions per minute (rpm)

3. Hard copy and digital file of all borehole drilling deviation surveys. Digital file for input into Microsoft Excel spreadsheet shall contain: general project and borehole information, surveyed ground location of injection hole, depth of survey, deviation in transverse and longitudinal directions, and total deviation.

Other records submitted shall include: test samples taken from grout cubes, wet samples of soil-cement, core samples, water pressure tests, permeability, and any other information from construction of jet grout cutoff wall.

SD-13 Certificates

Factory Calibrations on Instruments Used for Control of Jet Grouting

A factory calibration shall be done on all instruments used for control of the jet grouting. Certification shall indicate that the test equipment used for this purpose is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements and that, where applicable, are traceable to the National Institute of Standards and Technology. Calibration certificates (obtained for each instrument within one month of start of project) shall be maintained on-site for the duration of the project for the following instruments:

Drilling Instruments:

RPM's (N)	(rev/sec)
Torque transducer (T)	(kN * m)
Thrust on drill rods (F)	(kN)
Drilling speed (R)	(m/sec)

The above drilling parameters will be used to calculate the specific energy (E) versus depth as:

$$E = F/A + 2(P)NT / (A R)$$

where "A" is the cross sectional area (m^2) of the borehole, and "P" equals 3.14

The value of specific energy, "E" (kJ/m^3), will be plotted versus the drilling parameters on the same graph for ease of visualization

Jet Grouting Instruments:

water:	pressure, flow rate
air:	pressure, flow rate
grout:	pressure, flow rate, density
depth:	depth indicator

Factory Calibration on Borehole Surveying Instruments

Factory calibration certificates (within one month of start of project) for all borehole surveying instruments.

Cement Certification

Statement signed by an authorized official to certify on behalf of the manufacturer of the cement attesting that the products meet specified requirements. The statement must be dated after the award of the contract, must state the Contractor's name and address, must name the project and location and must list the specific requirements which are being certified.

Weigh Bills for Jet Grout Waste

Copies of weigh bill shall be submitted daily to the Contracting Officer during the progress of the work. The Contractor shall furnish the Contracting Officer or his designated representative scale tickets for each load of material weighed, date, time, and location of loading. Individual tickets shall be delivered to the Contracting Officer or his representative at the time of delivery or at the end of each work shift. A master log of all vehicle loadings shall be furnished for each day of loading operations. The Contractor shall file with the Contracting Officer the master log of loadings, certified weigh bills. Prior to the final payment, the Contractor will furnish written certification that the material recorded on the submitted weigh bills was actually used in the construction covered under this contract.

SD-14 Samples

Jet Grout Samples

Jet grout samples consisting of cored samples, wet grab samples, and cement grout samples taken by the Contractor which are not tested or taken for Government testing shall be submitted to the Contracting Officer.

SD-18 Reports

Survey System for Cutoff Wall; G

The survey system for locating the cutoff wall alignment and wall elevations and relating them to the contract drawings shall be established by the Contractor and submitted to the Contracting Officer. A survey system for locating the center of each jet grout drill hole shall be established by the Contractor and submitted to the Contracting Officer for approval. The locating system shall be able to re-locate the drill hole center within 25 millimeters (1-inch) of the location initially used to perform the injection. Submittal shall be stamped by a Land Surveyor registered in the State of California.

Jet Grout Construction Primary Line; G

The Contractor shall submit for each site, the layout and detailed jetting procedures for the primary line of jet grout cutoff wall construction, drilling methods, drilling deviation measuring techniques, jetting parameters to be used (all nozzle sizes, pump pressures, flow rates, rod rotation, lift speed, inter-axis spacing, column size), grout formulations, and any other information needed to construct the primary line of jet grout cutoff wall.

Jet Grout Construction Secondary Line; G

The Contractor shall submit the detailed jetting procedures, drilling methods, drilling deviation measuring techniques, jetting parameters to be used (all nozzle sizes, pump pressures, flow rates, rod rotation, lift speed, inter-axis spacing, column size), grout formulations, and any other information needed to construct the secondary line of jet grout columns using full cylindrical columns. The exact same data shall be submitted for partial columns ~~if the Government executes this option~~.

A specific layout of full cylindrical secondary line of columns for State Highway 160 shall be included.

Jet Grout Cutoff Wall at Light Rail Crossing; G

The Contractor shall submit a detailed layout and sequence of constructing the jet grout cutoff wall and interfacing with the jet grout cutoff wall in the roadways of Highway 160. The contractor shall also submit the jetting procedures, drilling methods, drilling deviation measuring techniques, jetting parameters to be used (all nozzle sizes, pump pressures, flow rates, rod rotation, lift speed, inter-axis spacing, panel length and column size), grout formulations, and any other information needed to construct the jet grout cutoff wall at the Light Rail Crossing

Results of Cement Grout Mixes with Water Compatibility;G

During all work, Portland Type I/II cement will be used. All cement grout will have a water/cement ratio of 0.70:1 (by weight). For this

water/cement ratio the average of three cubes shall have an average unconfined compressive strength of at least 7 MPa (1,000 psi) with no strength below 3.5 MPa (500 psi) at 7 days, and 17 MPa (2,500 psi) with no strength below 10.3 MPa (1500 psi) at 28 days shall be obtained. Contractor shall prepare grout cubes using cement and water source proposed for the jet grouting using W/C of 0.70:1.

The result from these grout cube tests shall be submitted at least 10 working days prior to any delivery of cement to the project.

Final Report; G

All data gathered including but not limited to: column and panel locations in plan and elevation, drilling and injection reports, borehole surveys, water pressure test data, all laboratory data, and an as-built plan and elevation view of the cutoff wall shall be continuously maintained by the Contractor. Five copies of the final cutoff wall data package shall be submitted within two weeks of demobilizing the site.

1.6 MEASUREMENT AND PAYMENT

The jet grout cutoff wall shall be predominantly constructed using a single row (primary line) of triple fluid jet grout columns. For each jet grout drill hole a drilling deviation measurement shall be performed prior to any jet grouting. Drill deviations shall be performed on each core hole and rotary exploratory holes along with borehole camera surveys. A limited amount of secondary jet grout treatment shall be performed as defined in paragraph 1.4.7.

Jet grouting shall be utilized across buried utilities that are to be protected inplace, three railroad crossings, one light rail crossing, and across State Highway 160.

Any jet grout hole, columns, panels, or partial columns lost or damaged as the result of mechanical failure of equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures shall be backfilled with cement grout and identically replaced by another corresponding jet grout column, panel, or partial column, drilled and injected by the Contractor at no cost to the Government.

1.6.1 Primary Line Jet Grout Cutoff Wall

Measurement for payment for the primary line of jet grout cutoff wall shall be based on installation of full cylindrical triple fluid jet grout columns for each site in accordance with the contract drawings and specifications and shall be based upon the square meter. The square meter shall be calculated by multiplying the horizontal distance between adjacent jet grout drill holes for the primary line and the depth interval of the jet grout cutoff wall. The depth interval of the jet grout cutoff wall is defined as the distance between the top of jet grout cutoff wall and the bottom of the jet grout cutoff wall as shown the contract drawings. The bottom of the jet grout cutoff wall as shown on the contract drawings shall correspond to the lowest point at which the air-water jet is activated to

perform triple fluid jet grouting. The jet grout cutoff wall cover shall be made incidental to the square meter measurement.

Payment for the primary line of jet grout cutoff wall for Site L2, except for the Regional Transit Light Rail crossing which is covered in paragraph 1.6.5, will be made at the contract unit price for Item "SITE L2 PRIMARY LINE JET GROUT CUTOFF WALL. Payment for the primary line of jet grout cutoff wall at Sites L3, L4, L4A, and R2 will be made at the contract unit price for Items "SITE L3 PRIMARY LINE JET GROUT CUTOFF WALL", "SITE L4 PRIMARY LINE JET GROUT CUTOFF WALL", "SITE L4A PRIMARY LINE JET GROUT CUTOFF WALL", and "SITE R2 PRIMARY LINE JET GROUT CUTOFF WALL", respectively. Such price shall include all costs of plant, labor, equipment, materials with the exception of cement grout, and all operations necessary including construction of the jet grout cutoff wall cover, all drill deviation measurements to complete the work specified in accordance with the contract specifications and drawings.

1.6.2 Secondary Line Jet Grout Treatment, Full Cylindrical Column

Measurement for payment for the secondary line of full cylindrical jet grout treatment shall be based on installation of full cylindrical triple fluid jet columns in accordance with the contract drawings and specifications and shall be based upon the square meter. The square meter shall be calculated by multiplying the horizontal distance between adjacent jet grout drill holes for the secondary line and the interval of the jet grout treatment. In the case of a single triple fluid column, the wall width shall correspond to the diameter of the column. The interval of the secondary line of jet grout treatment is defined as the distance measured between the upper and lowest depth at which jet grouting was performed as determined from the data acquisition for a particular column (and independently verified by the Contracting Officer). The actual elevations of the top and bottom of the secondary line of jet grout treatment shall be as directed by the Contracting Officer. The lowest depth of the jet grout secondary treatment shall correspond to the lowest point at which the air-water jet is activated to perform jet grouting.

Payment for the secondary line of jet grout treatment for the full cylindrical column will be made at the contract unit price for Items "SECONDARY LINE JET GROUT TREATMENT, FULL CYLINDRICAL COLUMN". Such price shall include all costs of plant, labor, equipment, materials with the exception of cement grout, and all operations necessary including, all drilling deviation measurements to complete the work specified in accordance with the contract specifications and drawings.

1.6.3 Secondary Line of Jet Grout Treatment, Partial Column ~~Option~~

Measurement for payment for the secondary line of partial column ~~(option)~~ jet grout treatment shall be based on installation of partial triple fluid jet columns in accordance with the specifications and shall be based upon the square meter. The square meter shall be calculated by multiplying the horizontal distance between adjacent jet grout drill holes for the partial column and the interval of the jet grout treatment. In the case of a single triple fluid partial column, the wall width shall correspond to the

diameter of the nearest primary line column, see sheet C-25. The interval of the secondary line of jet grout treatment is defined as the distance measured between the upper and lowest depth at which jet grouting was performed as determined from the data acquisition for a particular column (and independently verified by the Contracting Officer). The actual elevations of the top and bottom of the secondary line of jet grout treatment shall be as directed by the Contracting Officer. The lowest depth of the jet grout secondary treatment shall correspond to the lowest point at which the air-water jet is activated to perform jet grouting.

Payment for the secondary line of jet grout treatment for the partial column will be made at the contract unit price for Item "~~OPTION B,~~ SECONDARY LINE JET GROUT TREATMENT, PARTIAL COLUMN". Such price shall include all costs of plant, labor, equipment, materials with the exception of cement grout, and all operations necessary, including all drilling deviation measurements to complete the work specified in accordance with the contract specifications and drawings.

1.6.4 ~~Secondary Line of Jet Grout Treatment, Partial Column Alternate Option~~

~~Measurement for payment for the secondary line of partial column alternate (option) jet grout treatment shall be based on installation of partial jet columns in accordance with the specifications and shall be based upon the square meter. The square meter shall be calculated by multiplying the horizontal distance between adjacent jet grout drill holes for the partial column alternate and the interval of the jet grout treatment. In the case of a single partial column alternate, the wall width shall correspond to the diameter of the nearest primary line column, see sheet C-25. The interval of the secondary line of jet grout treatment is defined as the distance measured between the upper and lowest depth at which jet grouting was performed as determined from the data acquisition for a particular column (and independently verified by the Contracting Officer). The actual elevations of the top and bottom of the secondary line of jet grout treatment shall be as directed by the Contracting Officer. The lowest depth of the jet grout secondary treatment shall correspond to the lowest point at which the highest speed jet is activated to perform jet grouting.~~

~~Payment for the secondary line of jet grout treatment for the partial column alternate will be made at the contract unit price for Item "OPTION C, SECONDARY LINE JET GROUT TREATMENT, PARTIAL COLUMN ALTERNATE METHOD". Such price shall include all costs of plant, labor, equipment, materials with the exception of cement grout, and all operations necessary including, all drilling deviation measurements to complete the work specified in accordance with the contract specifications and drawings.~~

1.6.5 Jet Grout Cutoff Wall at Light Rail Crossing

Measurement for payment for the jet grout cutoff wall at Regional Transit Light Rail crossing within Site L2, as shown on Sheet C-22 in a detail plan and Sheet C-5 in plan and profile, shall be based upon the lump sum unit price for the jet grout cutoff wall installed in accordance with the contract drawings and specifications. Payment for the jet grout cutoff at the Regional Transit Light Rail crossing will be made at the contract lump sum price for Item "JET GROUT CUTOFF WALL AT LIGHT RAIL CROSSING". Such

price shall include all costs of plant, labor, equipment, materials with the exception of cement grout, and all operations necessary to complete the work specified in accordance with the contract specifications and drawings. All costs associated with permits and coordination activities with the light rail construction such as permits, removal and replacement of concrete barrier shall be included in the mobilization and demobilization for Section L2.

1.6.6 Cement Grout

Measurement for payment for cement grout (cement and water) shall be based upon the cubic meter as measured during active jet grouting by the data acquisition system used to monitor the grout flow and density at the grout plant for active jet grouting as shown on the contract drawings and specified in the specifications. Payment for materials to make the cement - water grout for all the jet grout sites (sections) shown on the contract drawings will be made at the contract unit price for Item "CEMENT GROUT". Such price shall include all costs for material, all grout testings, any transportation, loading and unloading, placement into silos or other storage bins for all cement and water used in the grout formulation. The total volume of water used for the grout preparation, including water used for the high pressure jetting and cleanup, shall be considered as incidental costs to this bid item.

1.6.7 Disposal of Jet Grout Waste

Measurement for payment for disposal of jet grout waste material shall be based upon the metric tons (2200 pounds) of jet grout waste material transported and disposed of at the landfill as measured from certified public scales in accordance with the contract drawings and specifications.

Payment for disposal of all jet grout waste material for all the jet grout sites (sections) as shown on the contract drawings will be made at the contract unit price for Item "DISPOSAL OF JET GROUT WASTE". Such price shall include all costs of labor and any and all equipment and materials, transportation required for disposal of the jet grout waste material in accordance with the contract drawings and specifications.

1.6.8 Core Drilling

Measurement for payment for coring of the jet grout columns shall be based upon the linear meters of core drilling at the unit price in accordance with the contract specifications. Payment for core drilling will be made at the contract unit price for Item "CORE DRILLING". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, transportation, temporary storage, and materials, including but not limited to wooden core boxes and all operations such as drilling deviation measurements, and any other operations necessary to complete the work specified in accordance with the contract specifications.

1.6.9 In-Situ Water Pressure Test

Measurement for payment for in-situ water pressure test shall be made for

each in-situ water pressure test in accordance with the contract specifications. A stage down test with a stage ranging from 3 to 5 meters (10 to 16.4 feet) shall constitute an in-situ water pressure test. Maximum depth for any test shall be 25 meters (82 feet). Payment for each in-situ water pressure test shall be made at the contract unit price for Item "INSITU WATER PRESSURE TEST". Such price shall include all costs of mobilization and demobilization,plant, labor, equipment, and materials, and all operations necessary to simultaneous perform two water pressure tests and complete the work specified in accordance with the contract specifications and drawings.

1.6.10 Unconfined Compressive Strength Test

Measurement for payment for an unconfined compressive strength test shall be made for each compressive strength test, excluding the cement grout cubes, in accordance with the contract specifications. Payment for unconfined compressive strength testing shall be made at the contract unit price for Item "UNCONFINED COMPRESSIVE STRENGTH TEST". Such price shall include all costs of plant, labor, equipment, materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.11 Permeability Test

Measurement for payment for permeability test shall be made for each permeability test in accordance with the contract specifications. Payment for a permeability test shall be made at the contract unit price for Item "PERMEABILITY TEST". Such price shall include all costs of plant, labor, equipment, materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.12 Slotted Steel Casing with Lexan Liner Option

Measurement for payment for slotted steel casing with Lexan liner (option) shall be made on a linear meter unit price in accordance with the contract specifications. Payment for testing shall be made at the contract unit price for Item "OPTION A,SLOTTED STEEL CASING WITH LEXAN LINER". Such price shall include all costs of plant, labor, equipment, transportation, and materials, and all operations, including installation, reaming of the Lexan Liner, double packer water pressure tests, and drilling deviation tests, necessary to complete the work specified in accordance with the contract specifications.

1.6.13 Rotary Exploratory Drilling

Measurement for payment for rotary exploratory drilling of the jet grout cutoff wall shall be based upon the linear meter unit price in accordance with the contract specifications. Payment for rotary exploratory drilling will be made at the contract unit price for Item "ROTARY EXPLORATORY DRILLING". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, and materials, including but not limited to all operations, including drilling deviations measurements, and any other operations necessary to complete the work specified in accordance with the contract specifications.

1.6.14 Borehole Camera

Measurement for payment for borehole camera shall be made at a daily rate as the unit price in accordance with the contract specifications. Payment for the borehole camera shall be made at the contract unit price for Item "BOREHOLE CAMERA". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, materials, copies of video tape, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.15 Deformation Monitoring Points

Measurement for payment for deformation monitoring points shall be made at the contract lump sum unit price for the deformation monitoring point at Site L4A and Borris type anchors supplied and installed in accordance with the contract drawings and specifications. Payment shall be made at the contract unit price for Item "DEFORMATION MONITORING POINTS". Such price shall include all costs of plant, labor, equipment, materials, and all operations necessary, including installation to complete the work specified in accordance with the contract drawings and specifications.

1.6.16 Fabrication of Cuttings

Measurement for payment for fabrication of jet grout cutting samples shall be made for each sample fabricated in accordance with the contract specifications. Payment for fabrication of jet grout cuttings shall be made at the contract unit price for Item "FABRICATION OF CUTTINGS". Such price shall include all costs of plant, labor, field tests specified in paragraph 3.6.1.2, equipment, temporary storage, transportation, and materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.17 Jet Grout Cutoff Wall Cover

Where excavation of the levee crown or construction of a jet grout waste conveyance system is advantageous to the Contractor's jet grouting operation and practicable, the costs of restoration of the levee in accordance with SECTION 02333; LEVEE RESTORATION, EARTHWORK, AND ROADWORK shall be incidental to the cost of the primary line of jet grout cutoff wall for that site.

1.7 SCHEDULE

The schedule shall be based on starting construction work upon completion of the Jet Grout Test Section. Jet grout construction for sites (Sections) L4 and L4A shall be performed after the Jet Grout Test Section is completed. The remaining sites shall follow in an order determined by the Contractor. The schedule shall reflect the requirements of specification 1034/1189, SECTIONS 01505 and 01506 which includes permits and coordination activities with Union Pacific, Caltrans, and Regional Transit. The schedule shall reflect milestone dates such as site preparation work, mobilization of jet grout equipment, and jet grouting work identified in their submittal for schedule and sequence of operations. In order to meet

the requirements of the owners, night shifts and or double shift (may include night shifts) operations may be needed.

PART 2 PRODUCTS

2.1 MATERIALS

The Contractor shall maintain at the job site a sufficient quantity of raw materials and other supplies such that the work can proceed uninterrupted by material shortages. The grout to be used shall be suitable for the project.

2.2 CEMENT

The cement shall be free flowing and not contain lumps which would clog the jets. Cement shall be Portland Cement Type I or Type II (per ASTM C 150). A written certification specifying cement quality shall be provided by the cement supplier and the Contractor shall provide a record copy to the Contracting Officer.

2.3 ADMIXTURES

Admixtures may be used in the mix, provided they be shown necessary to satisfy coreability, permeability or other technical requirements and approved by the Contracting Officer. The Contractor shall have on file a written statement as to the use of any such admixture, its effect on the grout mix, its long-term stability, and its effect on the environment.

2.4 WATER

The Contractor shall supply all water required for mixing the grout, cleaning equipment, and all other purposes needed by the Contractor. Any and all equipment, trucking, and piping required to transport water to the site will be the responsibility of the Contractor. Contractor is responsible for obtaining all required permits.

Water from the landfill may also be available. The Contractor shall make arrangements with John Olesen at (916) 264-7432 and pay any fees in advance.

The water shall be tested at the start of construction from each source and shown to be free from oil, organics, acids, alkali, or other deleterious substances. The water shall be free of turbidity, clean, fresh, and comply with the standards set below:

a. A pH equal to 7.0 plus or minus 1.0.
b. Total dissolved solids not greater than 500 parts per million.
c. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.
d. Hardness less than or equal to 50 ppm (Recommendation Only).

Once a week the temperature of the grout mix water from all water sources. contained shall be taken and recorded.

2.5 MATERIAL STORAGE FACILITIES

The Contractor shall provide all necessary materials, equipment and personnel to store cement and proposed admixtures under conditions to prevent moisture or other contaminants from mixing with the materials prior to use in the grout mix.

2.6 ENVIRONMENTAL PROTECTION

The raw materials and other supplies used in the construction of the jet grout cutoff wall and any temporary jet grout waste disposed of within the project limits or at any landfill shall be non-hazardous and shall comply with specification 1034/1189, SECTION 01355 ENVIRONMENTAL PROTECTION to prevent, and provide for abatement and control of, any environmental pollution arising as a part of the work.

2.7 SLOTTED STEEL CASING AND LEXAN LINER OPTION

The target size of the slotted steel casing with Lexan is 102 mm (4 inch) diameter steel pipe or less. The actual diameter of the casing shall be selected by the Contractor and be capable of having a borehole camera, (see Paragraphs 1.4.10 and 2.8, lowered inside of a 27.4 meter (90 feet)long string of casing. A second requirement for the casing diameter shall be related to the need to perform double packer tests inside the slotted steel casing once the Lexan liner is reamed out of the steel casing.

Lexan is a product manufactured by General Electric and is a ploy-carbonate class of plastic. Lexan can be obtained from plastic suppliers.

The casing shall be fabricated in lengths such that a minimum of 76 mm (3 inch) wide slots can be formed continuously along the pipe to within 305 mm (12 inches) of the ends of the pipe. The 76 mm (3 inch) slot is measured along the circumference of the pipe. A second 76 mm (3-inch) wide slot shall be formed along the casing at 180 degrees from the first slot.

The fabrication of the slots and selected length of casing shall produce a slotted casing which retains its circular shape to allow insertion of a Lexan liner to cover the slots in the casing.

The Contractor shall provide minimal essential interruption of the continuous slot in order to provide the maximum viewing area with due consideration of the need to view materials being jet grouted; the interval and width of packer to be used, and the need to effectively remove the Lexan lining without damaging the steel casing.

The coupling between pipe segments shall produce a flush joint inside and out which is capable of forming a water-tight seal between pipe segments, and also provide for alignment of the 76 mm (3 inch) slots along a 27.4 meter (90 feet) string of steel casing. The 27.4 meter (90 feet) is the longest string of casing required for the jet grout cutoff wall. The alignment of the pipe sections will permit viewing of the jet grouting via a borehole camera for a maximum depth of 27.4 meters (90 feet). The lowest section of steel casing will have a water-tight cap to close off the bottom of the 27.4 meters (90 feet) long string and prevent jet grout from

entering inside of the Lexan lined slotted steel casing.

The slotted steel casing shall have a Lexan liner which will have an inside opening to allow entry of a borehole camera for purposes of viewing the impact of the jet grout against the face of the Lexan. The ends of the Lexan shall be sealed against the inside face of the slotted steel casing to prevent jet grout from entering inside of the Lexan and slotted steel casing.

The Contractor shall have a tool which has the capabilities of reaming out the Lexan from inside the steel casing for a length of 27.4 meters (90 feet).

Prior to performing any fabrication the Contractor shall submit shop drawings for approval of the slotted steel casing and Lexan liner assembly, as per Paragraph 1.5 SD-04, DRAWINGS.

2.8 BOREHOLE CAMERA

The borehole camera shall meet the following:

1. Camera and all attached appliances shall fit within any core hole and rotary exploratory hole used on the project and within the inside diameter of the Lexan liner utilized in the manufacture of the slotted steel casing option specified in Paragraph 2.7 and submitted under Paragraph 1.5. Camera shall be able to easily pass through the entire length of all holes and/or Lexan lined steel casing.

2. Camera must be capable of operating to a maximum depth of 30 meters (100 feet) of water (43 psi water pressure).

3. Camera shall be capable of pan/tilt and 360 degree rotation in a horizontal plane when suspended vertically inside the borehole and Lexan liner specified above under item 1. An alternative pan/tilt and 360 degrees rotation of the camera field of view can be submitted subject to approval of the Contracting Officer.

4. Video camera and monitor shall be color and high resolution. Monitor shall be a minimum size of 9 inches.

5. VCR shall be at least 4 head with S-VHS input with toggle and freeze frame display.

6. Camera must be capable of operating inside any hole and Lexan liner as specified under Item 1 for a minimum of 4 hours without fogging or condensation. Camera shall be able to operate at a temperature of at least 65 degrees Celsius (150 degrees Fahrenheit).

7. The camera shall have variable lighting and prevent any glinting (reflective light)problems with viewing the side walls of any borehole or Lexan liner.

8. Camera shall be self-focusing or remotely controlled manually.

9. Controller and encoder will project on color monitor and stamp videotape with the following information in real time: hole or location identification, clock time (resolution to 1/30 second or better), and location (depth and orientation).

10. The Lexan option shall have elevation graduations and N-S-E-W directions markings on the inside such that it is readable from the camera inside the borehole.

11. For bore holes formed by coring or rotary exploratory drilling, the compass orientation (N-S-E-W) of the field of view shall be estimated for each elevation in which a camera survey is conducted. The compass orientation shall be recorded versus time and depth.

12. A dye injector appliance shall be an add-on which shall be attached to the frame of the borehole camera. The dye injector shall be able to inject a small amount of red dye below the view finder of the camera. The dye injection shall be able to be performed manually from the surface. The dye shall be compatible with the environment (i.e. dyes used in environmental work).

13. As part of the camera equipment, the Contractor shall provide 2 Cole Parmer battery operated thermistor thermometers (dual probes, plus four (4) 30.5 meter (100 feet) long each deep water thermistor probes or technically equivalent.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 General

The Contractor shall furnish all necessary plant and equipment for the jet grout cutoff wall construction including the preparation for and completion of all drilling deviation measurements. All equipment used for drilling boreholes; drilling deviation measurements; lowering, raising and rotating the jet rods; mixing grout; supplying pressurized grout and air-water to jets; and jet rods used to construct the jet grout columns shall have proven performance records for use in jet grouting work. The Contractor shall obtain and maintain at the job site spare parts and backup equipment to maintain jet grouting equipment in satisfactory operating condition to prevent loss of time due to mechanical breakdown or equipment failure.

3.1.2 Slotted Steel Casing with Lexan Liner Option

The Contractor shall fabricate slotted steel casing with Lexan liner similar to that demonstrated during the jet grout test section phase, and as approved by the Contracting Officer.

3.1.3 Jet Grout Drilling Equipment

Jet grout drilling equipment shall be of the type and capacity suitable for drilling in materials at the site and of the required hole sizes and

depths. Jet grout drilling equipment shall be suitable for drilling the jet rods to the depths required, then raising and rotating the jet rods to the depths and at the rates required for cutoff wall construction. If the drilling deviation instrument is attached to the jet rods then the instrument must remain operational for the entire depth of hole. The borehole shall be stable and have sufficient annular space between the jet grout drill rods and the side walls of the drill hole to be able to maintain a constant flush of cuttings to the surface. Drilling technique shall be able to achieve a maximum target drilling deviation of 1% or less. The presence of cobbles up to 0.3 meters (12 inches) as indicated by bulk samples from the project soil-cement-bentonite cutoff wall construction will necessitate drilling equipment capable of drilling through these materials. The equipment shall be capable of drilling and jet grouting to depths up to 30 meters (100 feet).

The jet grout drill shall have an integrated data acquisition system which during drilling will continuously monitor the following:

a. Clock Time
b. Drilling Speed (meters per second)
c. Thrust on Drill Rods (Kilo-newton)
d. Torque (Kilo-newton - meter)
e. Drill Rod RPM's (revolutions per minute, or indicate sweep angle)
f. Drilling Fluid Pressure (Mega-Pascal)
g. Specific Energy (kJ/m^3)

3.1.3.1 Partial Column ~~Option~~

~~If the Government exercises this option, then~~ ~~t~~The drilling equipment shall have the capabilities to form partial columns by rotating the rods in about a 120-degree arc and panels by rotating the rods in a sweeping motion to form about a 20-degree arc~~, or variation of the partial column alternate option~~.

3.1.4 Triple Fluid Jet Rods

The triple fluid jet rods shall have the capacity to be drilled through the gravel-cobble layer and then be used to convey the air, water, grout pressures and flow rates required to produce grout columns or panels in the work site soil types identified in the contract documents, and of the size and depth indicated in the specifications and drawings.

Additionally, the triple fluid jet rods shall have the capacity to accommodate a biaxial instrument for measuring the drilling deviations of the triple fluid jet rods. The instrument shall be able to fit inside the triple fluid jet rods or be attached to the bottom of the rods.

3.1.5 Grout Mixing and Injection Equipment

Grout mixers, holding tanks, water tanks, air compressors, and pumps shall be of sufficient capacity and design to ensure adequate supply of homogeneous grout, air, and water delivered at the required pressure to the

jet rods for a full work shift to produce grout columns of the required quality and dimensions.

The grout mixing equipment shall have a controlled weighing system for assuring that the dry and wet constituents of the grout are properly proportioned. Grout mixer/agitator will allow easy access for QC and QA personnel to obtain fresh samples of grout.

Grout plant will have mud balance, API Marsh funnel, and Fann Viscometer (driven by an electric motor) for manual checking of grout. It is planned to use the Fann Viscometer to measure the viscosity of the cuttings generated by triple fluid jet grouting. The Contractor shall utilize the Fann Viscometer employed during the Jet Grout Test Section phase of work. The Fann Viscometer shall be in working order when transferred to the Government at the end of the project.

Injection equipment required for the triple fluid system shall have the following MINIMUM characteristics. The Contractor shall evaluate the need for larger high pressure pumps to achieve the triple fluid panel lengths required at the locations shown on the drawings.

1. During triple fluid injection the high pressure pump shall have the capability of continuously pumping water at 45 MPa (6,500 psi) with a corresponding flow rate of at least 100 liters per minute (27 gallons per minute).

2. The cement pump used for the triple fluid system shall be able to continuously pump cement grout (w/c = 0.70:1; by weight) at a pump pressure of at least 18 MPa (2,600 psi) and corresponding flow rate of 150 liters per minute (40 gallons per minute).

3. Air flow pressure for the triple fluid shall not exceed 1.8 MPa (260 psi), nor shall the air flow rate exceed 1.5 cubic meters per minute (53 cubic feet per minute).

The above specifications for the pumps and air requirements do not necessarily correspond to the jetting parameters required for the work. Rather these specifications are the MINIMUM technical requirements for the equipment capabilities. If the Contractor believes that they require increased pumping capacity to satisfy the technical requirements of the jet grout cutoff wall, then they should mobilize larger pumping equipment. The above are a minimum REQUIREMENT.

Jet grout drill shall contain a data acquisition system and appropriate instrumentation to continuously acquire the following jet grouting parameters:

1. Clock Time
2. Water Pressure and Flow Rate
3. Air Pressure and Flow Rate
4. Grout Pressure, Flow Rate, and Density
5. Depth Below Ground Surface, and incremental lift speed
6. Drill Rod rpms or sweep angle (where applicable)

During jet grouting an LCD (Liquid Crystal Display) or paper strip recorder will be available for government Quality Assurance inspection so that the jetting parameters can be checked manually.

Once the jet grout column has been completed the Contractor will submit a hard copy of the output along with a digital record of the drilling, all deviation measurements and jetting parameters as part of the daily record.

3.1.6 Equipment Weight, Speed, and Width

The weight of drilling equipment to be used on the levee crown for the cutoff wall construction shall be limited to a maximum track vehicle weight of 25,000 kilograms (55,000 pounds). The weight of any trucks operating on the levee crown shall be a maximum gross loaded axle weight of 8,165 Kilograms (18,000 pounds). For work near the Regional Transit Light Rail tracks and across the Union Pacific Railroad tracks, the Contractor shall adhere to all equipment weight and clearances of each individual agency. In addition the Contractor shall adhere to the requirements of the Union Pacific Railroad haul road agreement(permit). The maximum operating speed of all equipment used on the levee crown roads shall be 24.1 kph (15 mph). The maximum overall width of jet grouting equipment used on the levee shall be limited to 3.6 meters (12 feet).

3.2 JET GROUTING ON LEVEE CROWN

3.2.1 Site Preparation

The Contractor shall locate utilities by pre-trenching and potholing prior to any jet grouting being performed in the vicinity. The Contractor shall protect in place all the near surface utilities shown on sheet U-2 and any other utilities uncovered during the Contractors utility location work.

The Contractor shall locate the position and width of the existing slurry wall by degrading the levee near the tangent point stations of the slurry wall listed on sheet C-20. The levee excavation and restoration requirements shall be in accordance with SECTION 02333.

Where appropriate, the Contractor may construct a jet grout cuttings diversion ditch along the jet grout cutoff wall alignment. A berm or other appropriate type of barrier shall be constructed to prevent movement of waste material outside the levee crown and construction right-of-way limits. In no case shall the jet grout cuttings be allowed to flow down the slope of the levee embankment. The levee excavation and restoration requirements shall be in accordance with SECTION 02333. Pavement removed due to construction of the jet grout cutoff wall shall become the property of the Contractor and shall be removed off site.

The Contractor shall use positive means for preventing jet grout cuttings from contaminating the ballast for the Union Pacific Railroad crossings. The details shall require the approval of the Contracting Officer and Union Pacific Railroad.

The details shown on sheet C-22, "DETAIL FOR RAILROAD TRACK JET GROUTING" are to be used for the Regional Transit Light Rail crossing. Any technical

alternative submitted by the Contractor shall require approval from the Contracting Officer and Regional Transit Light Rail.

The detail of the pre-trenching across the traffic lanes of State Highway 160 is shown on sheet C-21, "DETAIL FOR HIGHWAY 160".

Due to the constant traffic on Highway 160 and uncontrolled pedestrian access to the site, the Contractor shall develop a positive means for isolating all high pressure lines from accidental grout or water releases on to the roadway or inadvertent pedestrian access or injury. Positive means of isolation may include: use of appropriately sized steel pipe and fittings; direct burial of the high pressure lines surrounded by barriers and signage; and insertion of high pressure hoses inside appropriately sized steel pipe. These isolation methods shall be used for high pressure pumping from the grout plant to the jet grout working area. Contractor shall demonstrate the effectiveness of their positive means of isolation prior to any jet grouting. High pressure hydraulic hoses certified by the manufacturer will only be allowed for use unprotected at the surface in the actual jet grout working area.

The Contractor shall make a determination as to the adequacy of all ramps for mobilizing their equipment and accepting delivery of material. Improvements to the site, access ramps and roads shall be at the sole determination of the Contractor.

3.2.2 Surveys and Markers

The Contractor shall provide, install, replace and maintain all layout and necessary construction staking to locate the centerline of the wall within the allowable range of jet grout cutoff wall installation shown on the contract drawings. Surveyor's caps, appropriately identified to include survey control number, elevation, and name of the surveying company, and elevations and mounted on a minimum 10.2-centimeter (4-inch) diameter, 0.6-meter (2-foot) long steel pipe, driven into the ground, shall be provided at each end of the cutoff wall and at 7.6 meters (25 feet) maximum intervals between the ends. A tabulated list containing survey control numbers, grid coordinates, and elevations shall be submitted to the Contracting Officer within five (5) working days prior to the start of any construction. The coordinates and elevations shall have units consistent with the contract drawings. The caps shall be surveyed to establish initial elevation and final elevation to an accuracy of plus or minus 3 centimeters (0.1-foot) and these stakes shall be protected from damage or movement throughout the work. Survey construction control staking shall be performed by a California licensed surveyor and all survey data shall be stamped by the licensed surveyor.

Each jet grout drill hole shall be surveyed and marked in a manner that will allow relocation of the hole when the area is obscured (i.e. jet grout cuttings, mud, etc.). The Contractor shall provide, install, replace and maintain all layout and necessary construction staking to locate within 25 millimeters (1 inch) the center of any drill holes used during the construction of the jet grout cutoff wall.

The Contractor shall perform a pre-construction survey of all utilities and

railroad crossings and establish existing elevations of each structure. For the railroad crossings, survey markers will be attached to each rail along the centerline alignment of the jet grout cutoff wall.

Upon completion of the jet grout cutoff wall construction, permanent metal marker stakes shall be installed to indicate the location of each end of the cutoff wall. The levee station and levee kilometer/mile shall be indicated on the permanent metal markers.

3.2.2.1 Deformation Monitoring Points

For the railroad crossings, survey markers will be attached to each rail along the centerline alignment of the jet grout cutoff wall. For the sewer line (Site L4A) the Contractor shall probe for the lateral extent of the sewer and install a deformation monitoring point as shown on sheet C-25 to the crown of the sewer line. Borris type anchors as shown on sheet C-25 shall be installed along the levee crown and side slopes at locations selected by the Contracting Officer. Thirty (30) Borris type anchors shall be installed for this project. When jet grouting is being performed within 5 meters (16 feet) of any deformation monitoring point or survey marker the Contractor shall perform real time monitoring by automated or manual optical survey. See paragraph 3.3.5, "Displacement Response Values"

3.2.3 Drilling and Jet Grouting Sequence

The Contractor shall select equipment and drilling techniques to assure a stable drill hole. The drill hole shall have sufficient annular space between the jet grout drill rods and the side walls of the drill hole to be able to maintain a constant flush of cuttings to the surface. Drilling technique shall be able to achieve a maximum target drilling deviation of 1% or less. The presence of cobbles up to 0.3 meters (12 inches) as indicated on the logs of explorations contained in the contract drawings will necessitate drilling equipment capable of drilling through these materials.

Drilling technique shall be able to keep drilling deviations to 1 percent or less. Drill deviation measurements shall be taken for every jet grout drill hole, core hole, rotary exploratory hole with readings taken every 1.5 meter (5 feet)depth increment. The last reading shall be taken at the bottom of the bore hole.

The Contractor shall continuously record all the drilling parameters listed in paragraph 3.1.3 and provide a plot of specific energy versus depth for each drill hole. The specific energy data shall be superimposed over the soil stratification data reported from the nearest contract boring.

The drilling and grouting sequence shall be such that an adequate distance is left between the freshly installed columns and panels and any new injection. A minimum of approximately 36 hours (or an elapsed time determined from Test 1 of Phase 1 of the Jet Grout Test Section) shall elapse between injecting triple fluid jet grouting next to an installed column. Furthermore, the closest spacing shall be at least three inter-axis spacing or 4.5 meters (15 feet) (whichever is greater) prior to the 36 hour time elapse. The spacing between columns shall be measured

from center of installed jet grout column to center of proposed injection.

3.2.3.1 Horizontal and Vertical Alignment Tolerances

The maximum horizontal deviation of the as-installed center of any soil-cement element at the ground surface shall not exceed 25 millimeters (1-inch) from the layout center coordinate, shown on the Contractor's submittal. The vertical alignment of the drill hole shall not deviate in any direction more than one (1) percent from vertical. At the direction of the Contracting Officer, any soil-cement element which exceeds the allowable horizontal alignment tolerances shall be supplemented with one or more adjacent or overlapping elements, at no additional cost to the Government.

Once drilling is completed to final depth, the Contractor shall measure the drilling deviations for each hole prior to injection. The instrument to measure drilling deviations shall be the biaxial inclinometer approved by the Contracting Officer. Periodically, the Contracting Officer may require the Contractor to re-calibrate or re-test the inclinometer for accuracy against the readings taken from the inclinometers at the Jet Grout Test Section.

3.2.3.2 Jet Grouting Stage

A critical element for jet grouting is an assurance of a continuous flush of cuttings to the surface. This is especially true for jet grouting in the levee embankment and foundation soil above the gravel-cobble layer. When jet grouting is first initiated (for example after rod breaks) in the soils above the gravel-cobble layer (as determined by the drilling record obtained from the data in paragraph 3.1.3), the cement jet and water jets will be activated to the pressure, flow rate, grout density and rod rpm's as prescribed in the Contractor's submittal. The Contractor will not lift the jetting rods or start full flow of compressed air (very slight amount of air is acceptable) until steady flush of cuttings is observed at the surface. Thereafter, jet grouting will be conducted following the prescribed jetting parameters submitted by the Contractor. The Contractor shall supply triple fluid jetting monitor which will prevent clogging of the air jets while only injecting water and cement grout.

In the event that the above procedure cannot effectively produce a continuous flush of cuttings to the surface, then the Contractor shall submit for review an alternative drilling and jet grouting procedure. If the loss of cuttings to the surface continues, for jetting in the soils above the gravel and cobble layer, then the Contractor shall be required to use a cased hole through the levee embankment and foundation soil above the gravel-cobble layer. Plastic casing lined holes (i.e. PVC), which are cut by the high speed jet will not be allowed.

If incipient or actual blowouts through the levee embankment slopes occur during jet grouting, all jet grouting activities shall immediately stop and the Contractor shall notify the Contracting Officer. Jet grouting activities shall not resume until approval from the Contracting Officer is given.

3.2.4 Variation in Triple Fluid Jet Grouting

Variation in triple fluid jet grouting shall be conducted under several circumstances:

a. If the Contractor's selected drilling and triple fluid injection parameters causes embankment movements which consistently exceeds a total lateral or vertical displacement of 7 mm (0.25 inches) as measured by various monitoring points, variations in the triple fluid jet grouting method must be made.

b. Once the Jet Grout Test Section is completed, it may become apparent that the triple fluid system be performed without compressed air while jet grouting ONLY through the levee embankment. The Contractor shall include this jetting strategy as part of their planning for jet grouting, and assure that their triple fluid jet grouting equipment can operate in this mode.

3.2.5 Jet Grouting Waste

During jet grouting the Contractor shall provide weight tickets before and after each truck load of jet grouting waste taken from the site and disposed at the Florin-Perkins landfill. Any free water remaining over the hardened jet grout cuttings can be disposed of at the City of Sacramento landfill adjacent to the Jet Grout Test site. Contact John Olesen, (916) 264-7132, for schedule and fees for disposal.

Temporary storage of the jet grout cuttings may be used along the levee toe where permitted access is shown on the contract drawings. Any temporary storage of jet grout cuttings along the levee waterside toe shall be in structural containers which can be moved quickly in the event of high water conditions. Temporary in-ground storage pits shall be lined with an approved impervious landfill type plastic liner to prevent fluid escaping into the ground.

3.2.6 Working Surface

The working surface from which the jet grout cutoff wall is to be constructed shall be as defined in paragraph "DEFINITIONS". Except for the roadways of State Highway 160 and the railroad track crossings, the Contractor at no additional expense to the Government, may select and construct a working surface to a level no more than 1 meter (3 feet) lower than the existing levee crown for their own convenience.

Lowering the levee crown more than 1 meter (3 feet) at locations not specified on the drawings or specifications will require approval of the Contracting Officer. Upon completion of the jet grout cutoff wall construction and acceptance, the levee shall be restored to the original alignment and grade in accordance with SECTION 02333, LEVEE RESTORATION, EARTHWORK, AND ROADWORK. Material requirements, placement and compaction shall be in accordance with SECTION 02333, LEVEE RESTORATON, EARTHWORK, AND ROADWORK.

3.2.7 Triple Fluid Jet Grouting Work

Triple fluid jet grout injection, rotation, and extraction rates shall be sufficient to produce grout columns and panels meeting the depth, and performance requirements specified in paragraph 3.3, PERFORMANCE REQUIREMENTS FOR JET GROUT CUTOFF WALL. Any jet grout hole, columns, panels, or partial columns lost or damaged as the result of mechanical failure of equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures shall be backfilled with cement grout and identically replaced by another corresponding jet grout column, panel, or partial column, drilled and injected by the Contractor at no cost to the Government.

3.3 PERFORMANCE REQUIREMENTS FOR JET GROUT CUTOFF WALL

The performance requirements for the primary line of jet grout cutoff wall shall consist of two major criteria: wall continuity and hydraulic conductivity. The primary means of determining the wall continuity and in-situ hydraulic conductivity shall be by core hole drilling or rotary exploratory drilling, and measuring drilling deviations at locations determined by the Contracting Officer. It is planned to install a limited amount of secondary line of jet grout treatment as specified in paragraph 1.4.7, "Secondary Line of Jet Grout Treatment".

3.3.1 Wall Continuity for Primary Line of Jet Grouting

The continuity of the primary line of the jet grout cutoff wall shall have the following minimum properties as illustrated in sheet C-25:

1. Minimum total wall thickness shall be 1.02 meters (40 inches) for the entire depth of the primary line of the jet grout cutoff wall.

a. The Contractor shall expose the top of the jet grout cutoff wall at locations where core drilling or rotary exploratory holes are required. The original centers of the jet grout holes shall be re-established for determining the drill hole locations. Also the thickness of the exposed jet grout cutoff shall be measured and recorded.

b. The Contractor shall submit weekly as-built drawings consisting of the actual position of the jet grout columns, with plan view layouts starting at the surface and thereafter at 5-meter depth increments with the last plan view being the bottom of the wall. The minimum thickness of 1.02 meters shall be superimposed on each plan view along with the trajectory of the drilling deviation of the jet grout hole. Digitized data shall be submitted on magnetic media for a PC in Autocad format along with a hard copy output. The digitized data shall differentiate between primary, secondary, tertiary injection patterns for the primary line of jet grouting. The exact format of the digitized data shall be coordinated with the Contracting Officer.

c. The Contractor shall submit weekly tabulated values of effective column diameter (D), inter-axis spacing (I) at working surface, maximum total drilling deviations (e), and depth (z, at 5-meter intervals) for each jet grout column installed. Tabulations shall have a column of (D-I)/e values for each depth increment. Digitized data shall be submitted on

magnetic media for a PC in Microsoft Excel format along with a hard copy output. The exact format of the digitized data shall be coordinated with the Contracting Officer.

2. The effective zone of treatment for the central 60 percent of the wall shall be evaluated using the percentage of core recovered. For purposes of determining the location of the minimum 102 millimeter (4-inch) diameter core with respect to the effective zone of treatment, any portion of the minimum 102 millimeter (4-inch) diameter core which touches the effective zone of treatment shall adhere to the following criteria:

a. Soil-cement cores shall be retrieved from the top to within 1.5 meters (5 feet) of the bottom of the core hole. Core recovery shall be a minimum of 90% of a core run for soil-cement cured between 14 days to a maximum of 28 days. The maximum core run shall be 1.5 meters (5 feet). The minimum core diameter shall be 102 millimeters (4-inch) diameter. Core recovery is defined as:

(total length of recovered soil cement)/(total length of core run)x 100

b. Core recovery less than 50% of a core run, for soil-cement cured between 14 days to a maximum of 28 days, the Contractor shall perform additional jet grouting to repair the primary line over the interval of the core. The Contractor shall evaluate the reasons for the insufficient core recovery and submit a jet grouting plan to repair the defects in the primary line of treatment. The Contractor shall perform additional coring to determine the lateral extent of the defects in the primary line of jet grout cutoff wall. The depth and extent of repair shall be approved by the Contracting Officer. As soon as practicable the Contractor shall develop preventive measures to preclude the need for corrective measures. The additional coring and repair shall be performed at no cost to the Government.

c. For zones where core recovery is less than 90% but greater than 50% cured between 14 days to a maximum of 28 days, a borehole camera survey with selective dye injection shall be performed in a water filled corehole in which the water is maintained to the top of the corehole. The camera survey shall be performed over the entire depth of hole with particular attention paid to core runs with less than 90% recovery. After the borehole camera survey and dye injection is reviewed along with all other data, the Contracting Officer shall determine the need for repair of the primary line of jet grout treatment. If the data reveals physical defects, for example: pervious zones, cave-ins, voids, or areas of untreated soil then the primary treatment shall be repaired over the interval of the core, minimum repair length is 1.5 meters. The Contractor shall submit a jet grouting plan to repair the defects in the primary line of treatment. The Contractor shall perform additional coring to determine the lateral extent of the defects in the primary line of jet grout cutoff wall. The type of repair, depth and extent of repair shall be approved by the Contracting Officer. As soon as practicable the Contractor shall develop preventive measures to preclude the need for corrective measures. The additional coring and repair, and verification of the wall continuity shall be performed at no cost to the Government.

3. The cutoff wall outside the effective zone of treatment shall be evaluated using the percentage of core recovered. Soil-cement cores shall be retrieved to within 1.5 meters (5 feet) of the bottom of the core hole. For purposes of determining the location of the minimum 102 millimeter (4-inch) diameter core with respect to the total wall thickness, any portion of the minimum 102 millimeter (4-inch) diameter core which touches the total wall thickness (see sheet C-25) shall adhere to the following criteria:

a. Core recovery shall be a minimum of 70% of a core run for soil-cement cured between 14 days to a maximum of 28 days.

b. Core recovery of less than 70% shall have a borehole camera survey performed over the entire depth of hole. During the borehole camera survey particular attention shall be paid to core runs with less than 70% recovery. A borehole camera survey with selective dye injection shall be performed in a water filled corehole in which the water is maintained to the top of the corehole. After the borehole camera survey and dye injection is reviewed along with all other data, the Contracting Officer shall determine the need for repair of the primary line of jet grout treatment. If the data reveals physical defects, for example: pervious zones, cave-ins, voids, or areas of untreated soil then the primary treatment shall be repaired over the interval of the core, minimum repair length is 1.5 meters. The Contractor shall submit a jet grouting plan to repair the defects in the primary line of treatment. The Contractor shall perform additional coring to determine the lateral extent of the defects in the primary line of jet grout cutoff wall. The type of repair, depth and extent of repair shall be approved by the Contracting Officer. As soon as practicable the Contractor shall develop preventive measures to preclude the need for corrective measures. The additional coring and repair, and verification of the wall continuity shall be performed at no cost to the Government.

4. For any rotary exploratory hole, drilling deviations and borehole camera surveys shall be taken over the entire length of the borehole.

5. The Contractor shall submit weekly three copies of the video tape for each borehole camera survey, along with as-built drawings consisting of the actual trajectory of each core hole or rotary exploratory hole superimposed on the jet grout cutoff wall plan view layout at the working surface. The effective zone of treatment and minimum total wall thickness shall be superimposed on the plan view. The Contractor shall indicate the core depths which satisfy paragraph 3.3.1, part 2. and paragraph 3.3.1, part 3. All digitized data shall be submitted on magnetic media for a PC in Autocad format along with a hard copy output. The exact format of the digitized data shall be coordinated with the Contracting Officer.

6. All soil-cement retrieved from core runs shall be well mixed cemented soil without any visible air vesicles or untreated soil inclusions. The surface of the core runs shall resist a knife scratch (approximate depth of 1/16-inch) using moderate pressure on the knife.

7. The cement grout for all jet grouting shall have a water/cement ratio of 0.70:1 (by weight). The cement and water shall meet the requirements

specified in all appropriate paragraphs covering water, cement and grout.

8. Once the Contractor has demonstrated that their jetting parameters produce a compliant material, then the hydraulic horsepower for the water and cement pumps along with the kilograms of cement injected per linear meter shall not be less than 90% of the value selected by the Contractor. Once these limits have been established they shall be maintained and verified using the data acquired by the data acquisition system.

9. After all QC and QA evaluation has been performed, then the Contractor shall tremie backfill starting at the bottom of the core hole or rotary exploratory drill hole using low pressure cement grout specified in paragraph 3.3.1, part 7.

3.3.2 Wall Continuity for Full Cylindrical Columns Used for Secondary Line of Jet Grout Treatment

When full cylindrical columns are used for forming the secondary line of the jet grout treatment, the secondary columns shall be formed using the exact same drilling techniques and jetting parameters as the adjacent primary line of columns. The secondary full cylindrical columns shall be installed on a triangular pattern as shown on sheet C-25, and have a minimum overlap of 0.38 meter (15 inches) with each of the adjacent primary columns.

The continuity of the full cylindrical columns used in the secondary line of jet grout treatment shall have the following minimum properties as illustrated in sheet C-25:

1. All requirements specified in paragraph 3.3.1 for the primary line of jet grout cutoff wall shall be adhered to for the secondary line of jet grout treatment, with the exception for the definition of minimum total wall thickness and effective zone of treatment.

2. The effective zone of treatment shall be 60% of the minimum total wall thickness, see sheet C-25, for the combined primary line and secondary line of jet grout treatment.

3.3.3 Wall Continuity for Partial Columns Used for Secondary Line of Jet Grout Treatment

When partial columns are used for forming the secondary line of the jet grout treatment ~~(if option is exercised)~~, the partial column shall be installed using the installation method approved by the Contracting Officer. The zone of jet grout treatment to be covered by the partial column is shown on sheet C-25, PARTIAL COLUMN SECONDARY LINE OF JET GROUT TREATMENT, MINIMUM PROPERTIES.

1. The partial column shall fill in the zone defined by two lines drawn at 120 degrees apart with the drill hole (intersection of the two lines) located 400 millimeters from the surface of the primary column shown on

sheet C-25. The spacing between drill holes for two partial columns are illustrated on sheet C-25, PARTIAL COLUMN SECONDARY LINE OF JET GROUT TREATMENT, MINIMUM PROPERTIES.

2. The cement grout for all jet grouting shall have a water/cement ratio of 0.7:1 (by weight). The cement and water shall meet the requirements specified in all appropriate paragraphs covering water, cement and grout.

3. Once the Contractor has demonstrated that their jetting parameters produces a compliant material, then the hydraulic horsepower for the water and cement pumps along with the kilograms of cement injected per linear meter shall not be less than 90% of the value selected by the Contractor. Once these limits have been established they shall be maintained and verified using the data acquired by the data acquisition system.

3.3.4 Hydraulic Conductivity

The Contracting Officer shall examine all of the jet grouting and drilling deviation records and determine the location for hydraulic conductivity testing of the jet grout cutoff wall. The Contractor shall install an additional full cylindrical secondary line of treatment at the intersection of the primary line of the jet grout cutoff wall (see sheet C-25).

The in-situ hydraulic conductivity testing shall follow the procedure specified in paragraph 3.6.3.2, "In-Situ Water Pressure Testing". The Contracting Officer shall determine the elapsed time between installation of the secondary line of treatment and time of completion of the in-situ testing. As a guide for scheduling, the test shall be performed between 14 to 28 days after installation of the secondary line of treatment. The calculated in-situ hydraulic conductivity shall substantially conform to the following requirements:

Hydraulic Conductivity:	1x10-6	centimeter/second (maximum value not to be exceeded by 80% of the water pressure tests in-situ, and no value shall be greater than 1x10-5) for any individual production site

The laboratory hydraulic conductivity testing shall follow the procedure specified in paragraph 3.6.3.1, "Laboratory Testing on Cored Samples". The Contracting Officer shall select the cored samples for testing and the cured time. In general the laboratory hydraulic conductivity testing shall be performed on freshly extracted cores taken between 14 to 28 days after the installation of the column for the jet grout cutoff wall. The laboratory hydraulic conductivity tests shall be performed as a record test for the project.

3.3.5 Displacement Response Values

If at anytime during the jet grout cutoff wall construction, any displacement measurement equals or is greater than 7 millimeters (0.25 inches), then the jet grouting has exceeded a displacement response value. The jet grout column under construction will be completed, unless the side

slopes of the levee are experiencing a blowout, in which case the jet grouting shall cease immediately. The Contractor shall submit a plan to proceed forward with construction of the next columns to minimize surface and lateral movements below 7 millimeters (0.25 inches). The Contractor shall continuously observe the area of construction for evidence of distress and take appropriate measures to preserve the integrity of the production area at all times.

3.4 CLEANUP AND SITE RESTORATION

The Contractor shall continually clean up jet grout wastes, debris and leftover materials resulting from the jet grout cutoff wall construction. Prior to demobilizing each individual site, the Contractor shall clear all debris which may have accumulated in the execution of the work. The Contractor shall be responsible for disposal of these materials off site in accordance with all Federal, State, and local regulations and codes.

All excavations used for temporary storage facilities shall be backfilled using the on site native material and supplementing any additional material with similar material. The material shall be placed in a maximum loose lift thickness of 0.3 meters or (12 inches) and compacted to at least 90 percent of ASTM D 698. A minimum of three in-place field density tests and a laboratory compaction test representative of the material being compacted in accordance with ASTM D 698 shall be performed. Tests shall be taken near the start, middle, and end of placement.

3.5 DISPOSAL OF WASTES

The jet grout cuttings shall be removed from the site and any temporary stockpiles. The Contractor shall be responsible for disposal of any supernate above hardened jet grout waste, handling of jet grout waste for temporary stockpiling on the ground covered with an approved liner, and loading/unloading of jet grout waste into trucks for final transport to a certified landfill. The jet grout solid waste shall be disposed of at and in accordance with the landfill requirements specified in specification 1034/1189, SECTION 01572.

3.6 QUALITY CONTROL

The Contractor shall be responsible for project quality control records. Observations, measurements, and tests described in these specifications shall be performed for quality control. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by the Contracting Officer's Representative at any time.

The laboratory facility and personnel shall meet the requirements specified in specification 1034/1189, SECTION 01451. The laboratory personnel performing the hydraulic conductivity tests on soil-cement materials shall have at least two years of experience performing the specified tests on these types of materials and have performed these tests in sufficient numbers to insure reliability of results. No work requiring testing will be permitted until laboratory test facilities have been approved and or

inspected by the Contracting Officer.

A trailer with moisture and temperature control environment meeting the requirements of the specifications shall be provided by the Contractor for temporary storage of samples at each of the staging area sites. For long term storage of samples, the samples shall be transported to a laboratory having the environmental conditions meeting the specification requirements. Storage of the samples shall be for a maximum of 4 months after completion of jet grouting.

3.6.1 Jet Grout Soil-Cement Samples

The Contractor shall provide representative duplicate samples to the Government's QA laboratory, with the exception of the cutting samples. The Contractor shall deliver samples to a Government approved QA laboratory at the direction of the Contracting Officer.

3.6.1.1 Fresh Cement Grout Cubes

Uniformity of the grout mixture shall be verified by unit weight (density) measurements of the mixed grout by mud balance, taken at the mixing plant. This is to provide a manual check of the Contractor's data acquisition for the fresh grout. These manual measurements shall be taken at a minimum of one per 19,000 liters (5,000 gallons) of grout mixed and pumped. Three (3) sets of grout cubes (three cubes in each set) for a total of nine (9) specimens will be taken for every 95 cubic meters (25,000 gallons) jet grout column formed, to assure the quality of the cement and water. The preparation and storage, of the grout cubes shall be in accordance with ASTM C 109.

3.6.1.2 Fabrication of Cutting Samples

During the jet grout injection phase, bulk samples of the jet grout cuttings shall be obtained for every fifth primary line column installed. Bulk samples shall be collected at three different depths such as bottom, middle, and top of column. Enough wet bulk samples shall be obtained from each depth to fill four (4) ASTM approved cardboard molds, 76-millimeter (3-inch) diameter by 152-millimeter (6-inch) long cylindrical test specimens. The wet bulk sample shall be poured into the molds and rodded or vibrated to remove trapped air pockets and then sealed. The wet bulk density and the cured bulk density shall be recorded for all samples fabricated. The specimens shall be stored in a laboratory constant temperature, saturated environment and also be in accordance with ASTM D 4832, until tested or until otherwise directed by the Contracting Officer.

For every column in which bulk samples of the cuttings are obtained, wet bulk density, water content measured in the field, and Fann Viscometer (driven by an electric motor) readings shall be taken of sample cuttings generated at the bottom, middle and top of the jet grout column. The Fann Viscometer test shall be performed within one minute of the cuttings being ejected out of the borehole. The temperature before and after the Fann Viscometer test shall be recorded. On completion of the project using the Fann Viscometer it shall be returned to the Government in good operational working condition.

3.6.1.3 Core Drilling and Cored Samples

During the coring operation, information shall be obtained about characteristics of the jet grout cutoff wall that may or may not be apparent from the core recovered from the hole. Observations of the drilling action must be made and reported to present as complete a picture, as possible of the consistency of the cutoff wall. When coring, the Contractor's quality control representative should note the amount of water return to the amount being injected through the drill rods. Careful observation of drill water return changes can indicate a potential defective zone. While the drill rod is rotating, the drill action and rate of penetration shall be noted and recorded. Changes in drilling rate can be related to changes in wall composition and provide complimentary data in areas of poor core recovery. Basic information to be included on each core boring log should include: size and type of core bit and barrel used; bit changes; depth; length; and time for each run; and amount of core actually recovered.

All cored samples shall be a minimum continuous 102-millimeter (4-inch) diameter core samples. Core drilling technique shall be capable of keeping drilling deviations to a value of 1 percent or less. Coring of the jet grout bodies shall be performed by the Contractor or sub-Contractor performing the jet grout work or drilling contractor, experienced in coring cemented soil, having equipment and procedures that minimize drilling deviations, and capable of obtaining undisturbed core samples. In that the core recovery for the jet grout material is unique and the information from coring is critical to the verification of cutoff wall continuity, submittal data on equipment and procedures requires Government approval.

All core boxes shall be stored in a laboratory moisture room having constant temperature, saturated environment meeting the requirements of ASTM C 511 until tested or until otherwise directed by the Contracting Officer. Other requirements for the core drilling are specified in paragraphs 3.3.1 and 3.3.2.

All core holes shall be measured for deviations once all of the samples have been extracted from the boring. Location and scheduling of coring shall be as directed by the Contracting Officer. In general about 20 percent of the cutoff wall length (primary line) is estimated to be cored.

3.6.1.4 Rotary Exploratory Holes

Rotary exploratory drilling (such as tri-cone Tungsten roller bit) shall be selected by the jetting grout contractor to produce a minimum 102 millimeter (4-inch) diameter borehole using only water or air as the drilling fluid. The borehole shall be able to accommodate the borehole camera required in this specification. Drilling deviations shall be measured for all boreholes. The other requirements for the rotary exploratory drilling are specified in paragraphs 3.3.1 parts 4 and 5.

3.6.2 Jet Grout Compressive Strength Testing

3.6.2.1 Fresh Cement Grout

Three (3) grout cubes will have unconfined compressive strength test (ASTM D 4832) performed on samples cured at three (3), seven (7), and twenty-eight (28) days, except samples shall be formed using molds conforming to ASTM C 109.

3.6.2.2 Strength Tests of Cuttings

Three (3) specimens from each of the columns sampled as specified in Paragraph 3.6.1.2 (one specimen from top, middle, bottom of column) after curing for three (3) days, seven (7) days, fourteen (14) days, and twenty-eight (28) days, shall be subjected to an unconfined compressive strength test (ASTM D 4832). Changes in the testing may be required, as directed by the Contracting Officer. The need for such changes will be determined, based at least in part, on the results of the quality of the specimens tested.

3.6.2.3 Strength Tests of Cored Samples

Test specimens from core samples shall be selected as follows:

a. All cored samples which appear relatively weak with respect to the initial field hardness test as specified in paragraph 3.3.1, part 6.

b. At a minimum of one sample from the top, middle, and bottom of each column cored.

The samples shall be subjected to an unconfined compressive strength test (ASTM D 4832). The strength tests shall be performed on specimens from the same core run used for permeability tests.

3.6.3 Permeability Testing

3.6.3.1 Laboratory Testing on Cored Samples

Test specimens from samples of continuous core obtained from jet grout cutoff wall selected from the core run in which unconfined compressive strength tests were performed will be tested for permeability, wherein, three (3) samples (one sample from the top, middle, and bottom of the same column). Additional testing may be required, as directed by the Contracting Officer. The need for such additional testing will be determined, based at least in part, on the results of the quality of the specimens tested. The permeability tests shall be performed on specimens from near the same core run used for unconfined compressive strength tests and taken from the zones in which in-situ water pressure testing was conducted. The permeability or hydraulic conductivity shall be performed in accordance with ASTM D 5084. Test shall be performed as described in Method C. Alternatives to Method C may be used only if approval is granted by the Contracting Officer.

The permeability test parameters are as follows:

a. The following back pressure saturation and consolidation stages incorporated simultaneously shall be as follows:

These are the cell and backpressure stages to be applied during the initial application to achieve 10 psi effective confining pressure. The final stage of cell and back pressure will correspond to the pressures which produce a B coefficient equal to or greater than 0.95. In no case shall the cell pressure exceed 100 psi.

Stage	Cell Pressure (psi)	Back Pressure (psi)	Effective Confining Pressure (psi)
1	5	3	2
2	10	8	2
3	20	15	5
4	30	20	10
5	40	30	10
6	60	50	10

b. Saturation shall be confirmed by measuring the B coefficient.

c. The initial gradient used during permeation shall be 20.

d. Plots of the ratio of inflow to outflow, gradient, and hydraulic conductivity versus time shall be required for each test. Lines describing the boundary limits for the termination criteria listed in ASTM D 5084 shall be included on the plots.

e. The permeate liquid shall be American River water.

f. The specimen top cap, bottom cap, and porous end pieces shall have a diameter equal to the diameter of the test specimen +/- 2%. The diameter of the core samples will be a nominal diameter 102 millimeters (4 inches) and approximate length of 152 millimeters (6 inches).

g. Head shall be increased on the inflow end at the bottom of the specimen to a pressure which will develop the gradient specified in part c.

3.6.3.2 In-Situ Water Pressure Testing

The purpose of performing the in-situ water permeability test is to aid in evaluating wall consistency relating to seepage barrier performance. The in-situ water pressure tests in the jet grout bodies shall be performed by the contractor performing the jet grout work or an experienced contractor that have drilled and conducted water pressure tests in soil-cement or weak rock formations. Conducting water pressure tests for this material is unique and the information from this test is critical to the evaluation of cutoff wall performance. Water pressure testing will be conducted as a staged down test, using a single packer for the second stages and deeper. The maximum stage will be 5 meters (16.4 feet). The test stage shall be core drilled and 102-millimeter (4-inch) diameter core retrieved. The borehole will be washed out until clean water flows from the hole. Water pressure tests shall be conducted as follows:

1. A low pressure for 10 minutes. This followed immediately by
2. A moderate pressure for the next 10 minutes, then
3. A peak pressure for the next 10 minutes, then the
4. Moderate pressure again for the next 10 minutes
5. The low pressure for the final 10 minutes

The peak pressures used during any stage of the tests shall depend upon the depth of the stage and quality of the core recovered. For planning purposes, the water pressure shall not exceed a peak pressure of 138 kPa gage pressure (20 psi gage pressure) for shallow depths and 551 kPa gage pressure (80 psi gage pressure) for the deepest stage of the test. Maximum depth for any test shall be 25 meters (82 feet).

The Contractor will record information on date, times of testing, top and bottom of stage, gage pressure and pressure at mid-stage, total flow for 10 minute increment, and Lugeon value for each of the five test increments prior to moving to another stage.

The second and subsequent stages shall be cored, washed, and have a single packer placed at the top of the stage to be tested. Five step water pressure test shall be conducted as stated above.

During each portion of the water pressure test, pressure-flow-time data will be taken. Flow meter will have sufficient resolution for tests, and should be able to resolve the volume reading to at least 0.1 liter per meter x stage length in meters. Down the hole tubes through the packer shall have a minimum internal diameter of at least 25 millimeters and coupling shall be flush internally. There shall be no restrictions through the system. The hose connecting to the test gear should also at least 25 millimeters and a maximum length of about 1 meter.

Contractor will pressure test system up to 689 KPa gage pressure (100 psi gage pressure) prior to use and verify that there are zero leaks in the lines, fittings, and values used to conduct the water pressure test. The Contractor shall submit method to verify that the single packer does not have by-pass leakage during water pressure test.

3.6.3.3 Jet Grout Cutoff Wall Cover

Testing shall be in accordance with SECTION 02333, LEVEE RESTORATION, EARTHWORK, AND ROADWORK including the frequency and type of tests to be performed.

3.6.4 Cutoff Wall Measurements

The depth interval of each column shall be continuously measured and recorded. The wall and overlap distance shall be continuously measured, and recorded. The information shall be submitted daily to the Contracting Officer.

3.7 EXCAVATIONS

Excavations to expose the jet grout bodies for coring and connecting the jet grout cutoff into the existing SCB cutoff wall shall be as described in

SECTION 02333, LEVEE RESTORATION, EARTHWORK, AND ROADWORK. Excavations for Contractor elected levee degrading shall be as described in SECTION 02333, LEVEE RESTORATION, EARTHWORK, AND ROADWORK.

3.8 RECORDS

Records shall be maintained by the Contractor for all testing, measurements, and inspections performed to ascertain that the jet grout cutoff wall construction meets the specifications. Required reports, records, and documentation shall be furnished to the Contracting Officer daily. The Contractor's required records are outlined below.

3.8.1 As-Built Plan and Elevation of Jet Grout Cutoff Wall

An as-built plan and elevation view of the cutoff wall shaft and embankment fill shall be continuously maintained by the Contractor. These profiles shall be delivered to the Contracting Officer at the end of the shift in which the facility was completed. The as-built jet grout column locations and other information specified in paragraphs 3.3.1 and 3.3.2 shall be submitted to the Contracting Officer on a weekly basis.

3.8.2 Results

The results of all construction quality control testing required in these specifications shall be furnished by the Contractor. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made. All test results used for Quality Control shall be maintained in an electronic data base system compatible with Microsoft Excel or AutoCad as per the appropriate parts of the specification. Specification values shall be shown with the test results and shall be updated weekly and provided. Upon completion of the job, an electronic copy shall be submitted.

3.8.3 Construction Log

The Contractor shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made.

3.9 QUALITY ASSURANCE

The Government will collect and perform quality assurance testing. The Government testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. All testing procedures being conducted by the Contractor shall be available for inspection by the Contracting Officer at any time.

-- End of Section --

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JET GROUT TEST SECTION

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SECTION 02334

JET GROUT TEST SECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN PETROLEUM INSTITUTE (API) STANDARD SPECIFICATIONS

API SPEC 13A	(1993; 15th Ed.) Specification for Drilling-Fluid Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 109/C 109M	(1999) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1994) Standard Specification for Portland Cement
ASTM D 698	(2000a) Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
ASTM D 3740	(1996) Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 1556	(1990) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2487	(1993) Test Method for Classification of Soils for Engineering Purposes
ASTM D 4832	(1995) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

ASTM D 5084	(1990) Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM E 329	(1990) Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction

U.S. ARMY CORPS OF ENGINEERS

EM 385-1-1	(1996) Safety and Health Requirements Manual

1.2 SCOPE

The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, materials, and of performing all operations in connection with the construction of a jet grouting test section to support the construction of cutoff walls for the American River Levee Strengthening Project. An Instrumentation Contractor has installed all instrumentation required to monitor Phase 1 of the test section (under separate contract). The Jet Grouting Contractor will coordinate with the Contracting Officer on a daily basis regarding jet grouting activities which require monitoring via the instrumentation. All existing instrumentation shall be verified as properly functioning prior to the Phase 1 jet grouting at the test section. All new instrumentation shall be installed and verified as properly functioning prior to starting the jet grouting for Phase 2B.

There is a cutoff wall required for installation during the production phase of the project, (see separate contract documents). The schedule and cost of the production jet grout cutoff wall is driven by three main factors: 1) number of rows of columns to form the cutoff wall; 2) inter-axis spacing of columns to form a continuous wall; and 3)lift speed of jet grouting. In an attempt to resolve several questions related to these three main issues, the test section will be conducted in two main phases:

Phase 1 will be performed to examine the inter-relationship between the jet grouting parameters (especially lift speed), size of column and inter-axis spacing needed to form a continuous cutoff wall. The triple fluid system will be exclusively used. Both jet grout columns and panels will be formed. Drilling deviation measurements for the entire hole depth will be made for every deep (>10 meters or 33 feet) column, panel, core hole, and rotary exploratory hole drilled.

Phase 2 shall utilize the columns formed in Phase 1, (Test Series 2 and 5A) to form a small rectangular well (shaft). Two series of pump out tests will be performed in an attempt to quantify the overall conductivity of well wall. The first pump-out test will be performed on the shaft formed using a single row of triple fluid columns. Thereafter, a row of partial columns (see sheet C-3 for geometry) will be installed at the locations

illustrated on sheet C-3. Some of the partial columns may be replaced with full columns at the direction of the Contracting Officer. A second pump-out test will be performed to examine the impact of the partial columns on the overall wall conductivity. Once the pump out tests are completed the Jet Grouting Contractor shall excavate the area around the test shaft for a depth of about 4.5 meters (15 feet).

Phase 2 activities shall also examine the impact of jetting at various distances from the hinge point of a cut slope. The main objective of this series of tests will be to establish the near surface injection protocols and minimum distance from the hinge point to jet grout borehole, which will minimize the possibility of any jet grout break-out on the face of the slope.

The permissible staging area for the jet grout equipment is delineated on contract drawing sheet C-1. This site is bound on the north by the American River left bank levee; the west and the south side by the City of Sacramento landfill and Union Pacific Railroad; and the east by Business 80 Highway. The actual location of the Phase 1 jet grouting for Test Series 2 and 5A is also shown on contract drawing sheet C-1. All the jet grouting for these two test series will be performed within a 3 meter (10-foot) wide corridor. The layout of the instrumentation surrounding the jet grout corridor is illustrated on sheet C-3. The Jet Grouting Contractor must make every effort to prevent any damage to all the surface casing and buried wiring which connects the existing instrumentation to the logging van, (see sheet C-1). The Jet Grouting Contractor is not responsible for any instrumentation damaged by the active jet grouting process. For all the other test series and Phase 2B, the Jet Grouting Contractor shall submit a layout plan of the work location, spoil pits, grouting plant, and all other details required to assure that all work can be performed within the assigned work space.

The Jet Grouting Contractor shall attend a daily coordinating meeting (15 minutes) at the start of each shift. The meeting will allow the Contracting Officer to coordinate the jet grouting (Phase 1 and 2) with the instrumentation monitoring.

The above discussion outlines the general work required for the Phase 1 and Phase 2 portions of the jet grout trial field. Since this work is considered a test, the Government reserves the right to add and delete any and all portions of the work. The anticipated activities to be performed during the five test series required for the Phase 1 portion of the work are discussed in more detail in the following sub-sections.

1.2.1 Phase 1 Jet Grout Test Section

Prior to commencement of Test 1, the Jet Grouting Contractor shall proof test all equipment and instrumentation to verify that the equipment and instrumentation is working in an acceptable manner, and shall satisfy the minimum pumping requirements stated in paragraph 3.1.5. The proof test shall consist of a single 4 meter deep column which satisfies all the operational requirements for the Phase 1 test.

Phase 1 consists of 5 series of tests. The general layout of each test is

schematically shown in the contract drawings, sheet C-2. The letter squencing within a test shown on drawing sheet C-2 (i.e. Test 1, sequences A and B) is the sequence in which the jet grout element injection shall be started. It is not required that sequence A. be completed before proceeding to the jet grouting of the next letter designated sequence. The general scope of work to be performed for each of the five tests during Phase 1 includes:

1.2.1.1 Test 1: Cure Time Study and Borehole Camera Investigation

The purpose of these tests is to obtain an initial estimate for the lifting speed required to obtain various sized jet grout columns, (see sheet C-2 for range of sizes required). In addition, two lines of primary and secondary triple fluid columns will be installed to examine the impact which cure time has upon the soil-cement formed at the inter-face of two adjacent columns formed after a certain elapsed time. It is anticipated that two primary and one secondary line, 36 linear meters (128 linear feet) of columns, will be installed within the same shift. The last secondary line (Line 2b on sheet C-2 for Test 1) will be installed within a maximum elapsed time of 24 hours after formation of primary line 2. The cement grout used for all the secondary lines will be doped with a red dye to allow an easier differentiation between primary and secondary columns.

The Jet Grouting Contractor shall monitor the primary and secondary lines of treatment and make the determination when a backhoe can be used to excavate all the primary and secondary lines for examination of the inter-face between adjacent columns. However, the exhumation shall be performed prior to starting Test Series 2. It is anticipated that the jet grout columns will be exhumed in 0.5 to 1 meter (1.5 to 3-foot) increments, to a total depth of about 2.3 meters (7.5 feet). The backhoe will remove large block samples (about 1 meter square) of the inter-face during exhumation. The blocks will be transported and stored in a wet room for strength and permeability testing (0.1 meter or 4 inch cores) after about 28 days of curing. The remaining 2 meter or 6.5-foot thickness of columns shall be covered and left in the ground for curing and future testing during the core drilling and water testing stages of the trial field.

The second major activity to be conducted during the Test 1 Series is related to using a borehole camera as a means of detecting the jetting time required to cut through the soil and contact a steel/Lexan observation casing. The Jet Grouting Contractor shall design and fabricate a composite steel pipe with slots on the sidewall of the casing. The steel casing shall be lined with a Lexan pipe. A borehole camera shall be able to be placed inside of the steel/Lexan casing, which will act to protect the camera against damage from the jet grouting process. The observation casing shall allow viewing of the jet arrival in the field of view of the borehole camera for depths up to 20-meter (65-foot). The 6-meter or (20-foot) test for the borehole camera study, see sheet C-2, is used to allow coordination and evaluation of safety procedures between jet grouting and use of the borehole camera. The two 20-meter (65-foot) deep borehole camera study holes are used to examine the feasibility to detect the size of jet grout column immediately after it is constructed at about the maximum depth anticipated for the actual cutoff wall construction. One of the 20-meter (65-foot) camera holes will be used to examine the formation

of a large diameter column (2.0 to 2.5 meters or 6.5 to 8.2 feet) using a single lift speed during the entire process. The second 20-meter (65-foot) camera hole will be used to examine the formation of an intermediate sized column (1.75 to 2.0 meters or 5.7 to 6.5 feet). All observation casing shall be designed to allow the Lexan plastic to be bored out of the steel casing such that the Lexan liner shall be removed from the openings in the steel slots. The inner diameter of the steel casing shall allow in-situ water pressure tests to be performed over the interval of the steel slots. The Contractor shall demonstrate the capability of reaming the Lexan plastic from inside the steel casing. The reaming demonstration must be completed prior to starting Test Series 3.

The borehole drilling deviation measurement is a critical element for the successful installation of the jet grout cutoff wall. Prior to the start of Test 2, the Jet Grouting Contractor shall provide an in-hole, biaxial-axial inclinometer which shall fit directly inside of the triple fluid rods (or be attached to the bottom) and shall be capable of effectively measuring borehole verticality. This is an extremely important measurement to perform in the rods since all boreholes greater than 10 meters (33 feet)in length will have their drilling deviations measured (jet grout columns, panels, core holes, rotary exploratory holes, and steel/Lexan observation casing). The accuracy of the triple fluid rod inclinometer shall be tested by placing the inclinometer into each of the two existing 20 to 23.8 meters (65 to 78 feet) deep inclinometer casings, (see sheet C-3). A borehole survey shall be performed at 0.5 meter (1.6 feet) intervals. The Jet Grouting Contractor shall reduce the inclinometer data and submit tables and graphical representations of the borehole drift to the Contracting Officer. The Contracting Officer will make a determination as to the effectiveness of the Contractor's proposed device by comparison to a controlled survey performed with a standard Inclinometer bi-axial instrument. The Jet Grouting Contractor shall not proceed on to Test 2 until the Contracting Officer has accepted the Contractor's drilling deviation measurement procedures and in-hole instrument.

The number of columns installed during Test 1 are estimated as:

Triple Fluid Columns:	12 @ 4 meters
	2 @ 6 meters
	4 @ 20 meters

A total of 140 meters of columns shall be constructed as part of Test Series 1. All columns shall be exhumed and inspected to a depth of 2.3 meters (7.5 feet), or as per the direction of the Contracting Officer, prior to commencing Test Series 2.

1.2.1.2 Test 2: Selection of "Best" Production Columns

Test Series 2 is conducted to determine the "best" set of jetting parameters (especially, lift speed), effective zone of treatment and inter-axis spacing which could be used during production of a single row cutoff wall, see Test 2 on contract drawing sheet C-2. The largest and intermediate sized columns, shown on this drawing, are installed in the jet grout corridor in the location identified on drawing sheet C-3, which

identifies the column layout to form the shaft used as part of Phase 2A. Part of the selection criteria for identifying the "best" combination of variables, will be related to the Contractor's ability to obtain continuous core (20-meter deep) within the zone of treatment at the overlap of adjacent columns.

Three sets of 5 triple fluid columns (total 15 columns) will be formed. The drilling deviations for each and every column installed shall be measured prior to performing jet grouting. The jetting pressures, flow rates and W:C = 0.70 will be fixed at the start of the test. Paragraph 3.1.5, "Grout Mixing and Injection Equipment" identifies the minimum injection equipment required for the trial field. The first set of five columns will utilize the slowest lifting rate such that jet grout columns will be the largest practical size. The current design requires columns to be between 2.0 to 2.5 meters (6.5 to 8.2 feet) in diameter over a depth of approximately 20 meters (65 feet). The spacing between each of the five columns will be varied such that the inter-axis spacing will be approximately: 85%, 80%, 75% and 70% of the estimated column diameter obtained from Test Series 1. Two additional series of five columns will be formed in an attempt to form columns 1.75 to 2.0 meters (5.7 feet to 6.5 feet) diameter, and 1.5 to 1.75 meters (4.9 to 5.7 feet) diameter. The only jetting parameters which will be changed from each series of five columns will be the lifting rate, i.e. water injection pressure and flow rate, grout density, air flow rate and pressure all remain the same for all 15 columns.

During the formation of the 5 smallest diameter columns (1.5 to 1.75 meters or 4.9 to 5.7 feet) the Contractor shall utilize a diverter pipe for controlling the spoil generated. The diverter shall direct the spoil into a control volume for ascertaining the total volume of spoil generated during the jet grouting. During the formation of the other 10 columns the Contractor must use a positive means of controlling the flow of spoil into a control volume (example, steel tanks) for ascertaining the total volume of cuttings generated during the formation of each jet grout column. The Contractor shall control the cuttings and divert them into a control volume without disturbing the buried instrumentation cable which surrounds the site, see drawing C-3.

The number of columns planned for Test 2 are:

Triple fluid columns: 15 columns - 20 meters deep

1.2.1.3 Test 3: Panel Walls and Partial Columns

Many of the railroad crossings encountered during the production cutoff wall construction can be simplified if 4 meter (13 feet) long continuous triple fluid panels can be created. As part of Test Series 3 the Jet Grouting Contractor shall make a determination as to the need for larger water and grout pumps (than those specified in Paragraph 3.1.5) which shall be required to achieve at least a 4 meter long panel. Three pairs of panels (total of six) will be formed to a maximum depth of 6 meters (20 feet) with approximately 8 meter (26-foot) spacing between pairs. At least three different lift speeds shall be examined. The shallow panels shall be excavated in the top 2.5 meters (8.2 feet) to examine the lateral extent of the panels for each of the lifts speeds used. The jetting parameters which

produced a panel of at least 4 meters (13.1 feet) long shall be used in a borehole camera test setup to determine the lateral extent of the panels at depths of 6 and 20 meters (20 to 65 feet). Prior to performing the jet grouting, the Contractor shall measure the deviations of the 20 meters (65 feet) deep steel/Lexan observation casing.

As part of the panel test series, some of the shallow 6-meter (20-foot)wall panels shall be formed by using a slight sweeping motion of the drill rods during jet grouting (example +/- 10 degrees). As part of their submittal the Jet Grouting Contractor shall indicate the capabilities of their drilling equipment to form panels with a slight sweeping motion between lifts. These jet grout drill capabilities will also be required when forming a partial column (+/- 60 degrees from the central axis), which is part of Test Series 3B (see sheet C-2). The partial column alternative option suggested by the Contractor in their response to the Request for Proposal package shall be able to produce an equivalent area of treatment for the partial column geometry shown on sheet C-3. If this option is executed by the Government, then the work shall be performed during Test 3 of Phase 1.

During the formation of all panels and partial columns, the Contractor shall utilize a diverter/preventer system for collecting the spoil generated with no spillage. All spoils shall be collected in a control volume to determine the total volume of spoil generated for each of the elements formed during this test series.

The quantity of panels installed are estimated to be:

Triple Fluid Panels	7 - 6 meters (20 feet) deep 1 - 20 meters (65 feet) deep
Triple Fluid Partial Columns:	3 - 6 meters (20 feet) deep 1 - 20 meters (65 feet) deep
Partial Columns Alternate Option:	3 - 6 meters (20 feet) deep 1 - 20 meters (65 feet) deep

1.2.1.4 Test 4: Drilling Deviations Along the Levee

The first three test series require evaluation before proceeding further with the test section. Some of the jet grout bodies may require additional cure time prior to coring and performing water pressure tests. Therefore, for a period of about 5 to 10 days, the jet grouting drill will be used to bore test holes along other sections of the levee. These test holes will have the normal drilling parameters measured (Paragraph 1.5, "SUBMITTALS" SD-13 and Paragraph 3.1.3, "Jet Grout Drilling Equipment") and drilling deviations recorded for each bore hole. Each borehole will be backfilled with low pressure grout, (no jet grouting performed). It is currently estimated that 6 sites with 1 hole each will be installed during this phase of the test section.

When the jet grout drill is performing drilling deviation tests on the levee, the Contractor shall have all labor, equipment and materials needed to perform coring and water pressure tests on various columns formed in the

first three test series. A minimum of two complete water pressure testing equipment and labor is required to be performed simultaneously. The equipment and procedure for performing the tests shall be as per paragraph 3.7.3.2. The results from the cores and water pressure tests will be used to determine what jetting parameters and inter-axis spacing "best" represents production jet grout columns. This information will be used for selecting the jet parameters to be used for Test 5.

1.2.1.5 Test 5: Production Simulation

The first test will involve forming 8 triple fluid columns. Four (4) columns will be formed using a W:C = 0.7:1, with the other four (4) columns being formed using W:C = 1:1. A steel casing with borehole camera, as described for Test 1, will be used at one location per four columns. Each of the four (4) columns shall be installed within the remaining open side of the jet grout corridor. At the end of Test Series 5A the test shaft required during the pump down test performed during Phase 1 will be enclosed. If an additional column or two is required to close the shaft, (due to the pattern of installed columns) then these will be installed using the W:C = 0.70:1 cement grout injection.

During the formation of the 8 production columns the Contractor shall utilize a diverter pipe for controlling the spoil generated. The diverter shall direct the spoil into a measurable collector for ascertaining the total volume of spoil generated during the jet grouting. The Contractor shall take all precautions necessary to assure that there is no damage to the buried instrumentation cable which surrounds the jet grouting for Test Series 5A.

After about 3 to 5 days of curing, the Contractor shall ream the Lexan from inside the casing to allow water pressure tests to be performed using the slots in the casing. A couple of rotary exploratory holes with borehole camera surveys shall be performed 7 to 10 days after installation of columns. The second overlap intersection will be core drilled at about 14 days, and the last intersection at around 28 days. When the core drilling is successful, then water pressure tests will be done in different segments of the borehole. The procedure specified in Paragraphs 3.7.1.3, "Drilling of Cored Samples" and 3.7.3.2, "In-situ Water Pressure Testing" of the specification section will be followed. In the cored zones where water pressure tests are performed a borehole camera will be used to inspect the hole before and after water pressure testing. This is done to try and evaluate any damage to the core hole due to inflation of the packers used for water pressure testing. Once the core hole is completed a borehole camera survey will be used to video tape the side walls of the entire core hole, with particular attention to those core runs with less than 90 percent recovery.

The second setup of Test 5B, consists of a composite panel/column arrangement for use when the potential column centers are more than 2 meters (6.5 feet) apart, such as the Regional Transit Light Rail crossing at Highway 160. The actual spacing of the multi-row panels used in Test Series 5B, is based upon the results from the panel experiments performed in Test 3. A small pump out well shall be installed within the panel wall shown in the plan view on sheet C-2 for Test Series 5B. The pump out test

shall not commence until all jet grout bodies have cured for a minimum 72 hours.

The final experiment in the production series will be to form three triple fluid columns with a partial column as an in-fill over the overlap between the columns. The grout for the partial column shall be dyed red for ease in visual examination. The jet grout partial column alternate proposed by the Contractor shall be tested at this time if the option is executed by the Government. The proposed dye shall be acceptable environmentally and safe for discharge into the groundwater without any detrimental impact on water quality.

The estimated columns and panels installed during Test 5 are:

A). Cement Grout Variation Test Triple Fluid Production Columns;
4 - W:C = 0.7:1, z = 20 meters (65 feet) deep
4 - W:C = 1:1, z = 20 meters (65 feet) deep

B). Composite Panels/Columns,

4 triple fluid columns (W:C = 0.70:1), with 4 triple fluid panels, arranged in the pattern shown in Test Series 5B shall be formed to a depth of 20 meters (65 feet).

C). Partial Column Overlap 3 triple fluid columns w/1 triple fluid partial column, z = 6 meters deep. An additional partial column alternate option will be installed on the other side of the three column pattern shown on sheet C-2.

1.2.2 Phase 2 Full Scale Prototype Testing

The triple fluid jet grout columns formed in Tests 2 and 5A will be arranged in the shape of a small rectangular shaft, see contract drawing sheet C-3. Two sides of the shaft will be made up from Test 2 columns using the largest diameter and the intermediate size diameter. The other two sides of the shaft will be made from Test 5 columns having water to cement ratios of 0.7:1 and 1:1.

A second prototype will be setup in which potential break-out impact of jetting at various distances from the hinge point of a cut slope will be evaluated. The main result from this series of tests will be to establish the near surface injection protocols and minimum distance from the hinge point to jet grout borehole, which will minimize the possibility of any jet grout break-out on the face of the slope. Depending upon the results from the break-out tests some jet grout columns may be formed without compressed air, but using all the other production parameters.

1.2.2.1 Test Shaft

A pump out well shall be installed inside the shaft and a pump out test performed as per Paragraph 3.7.3.3, "Pump Out Test Wells". The pump out test shall not commence until all jet grout bodies have cured for a minimum of 72 hours. After the first pump out test the ground water will be allowed to come back into equilibrium. Thereafter, the partial column

elements (see sheet C-2, Test Series 3B) will be installed along the perimeter of the shaft to cover each of the overlaps between adjacent columns. After the partial columns have cured a second pump out test shall be performed to evaluate the efficiency of the cutoff wall.

After the completion of the second pump out test the outside of the small rectangular shaft will be excavated along all four sides for a depth of about 4.5 meters (15 feet) or to groundwater (whichever is first encountered). To insure levee stability only one side shall be exposed and backfilled before any other side is exposed. Based on site conditions encountered and evaluation by the Contracting Officer, more simultaneously exposed sides may be approved by the Contracting Officer. This is to allow for visual examination of the column to column contact near the surface.

1.2.2.2 Cut Test Embankment

Prior to construction of the cut embankment, the Contracting Officer shall coordinate the installation of the instrumentation to be placed on and in the cut embankment, see sheet C-4. The cut embankment will be approximately 3 meters (10 feet) deep, with side slopes of 3:1 and 2:1, which are generally the side slopes of the levee embankment. Four (4) jet grout columns approximately 5 meters (16.4 feet) deep will be installed at varying distances from the hinge point of the cut embankment on the 3:1 side of the embankment. The test series will be repeated on the 2:1 side of the cut. Several jet grout columns formed without air shall also be installed adjacent to the edge of the 2 horizontal to 1 vertical side slope. Additional tests may be required if there are no blow-outs on the side slopes of the embankment. The installation shall mimic the production installation by allowing columns to harden prior to forming a second jet grout column. The jet grouting parameters which "best" represent the production jetting parameters shall be used during the cut embankment test. The W:C = 0.70:1 shall be used during this test series.

For all the columns formed during the cut embankment test series the Contractor shall utilize a diverter pipe for controlling the spoil generated. The diverter shall prevent any spoil from flowing down the face of the embankment. The diverter system shall be capable of pumping the cut spoil into a concrete transit mixer. The total volume of spoil generated during the jet grouting shall be ascertained by weighing the transit mixer before and after each use, and obtaining density measurements of the cuttings generated from each borehole.

1.3 GEOTECHNICAL SITE CONDITIONS

1.3.1 Explorations

Subsurface explorations have been obtained by the Government and are included in the contract documents. Boring 2F-99-17 was drilled adjacent to the test section and boring 2F-00-114 was drilled further downstream, as shown on contract drawing sheet C-1. Logs of explorations are shown on contract drawing sheets B-1 and B-2. Explorations encountered difficult drilling conditions and coarse zones with gravel and cobbles. The groundwater level indicated on the logs of explorations are at the time of

drilling and will vary depending on time of year and river stage.

Additional detailed boring logs taken during the installation of the instrumentation are also available for review. Included in the boring logs are laboratory test data on selected samples including gradation, Atterberg limits, and moisture contents. This information can be made available for review to the prospective bidders upon request in accordance with SECTION 00100 INSTRUCTIONS, CONDITIONS AND NOTICES TO BIDDERS/OFFERORS AND EVALUATION CRITERIA FOR AWARD.

1.3.2 Contractor's Responsibility

It is the Contractor's responsibility to become acquainted and satisfied as to the character, quality, and quantity of surface and subsurface materials by inspecting the sites and by evaluating information derived from available exploratory work and the explorations that are required as part of this contract. Soil samples obtained during design explorations are stored at the West Sacramento Corps of Engineers Bryte Yard and can be made available to the Contractor for examination of samples. Any failure by the Contractor to become acquainted with all the available information and site conditions will not relieve him/her from responsibility for properly estimating the difficulty or cost of successfully performing the work. It is required that the Contractor locate existing utilities through excavation, probing or other suitable methods prior to jet grouting. The most current information indicates that there is a buried sewer line adjacent the jet grout staging area, as indicated in contract drawing sheet C-1. The adjacent landfill has a monitoring well and several methane gas probes at the locations shown on the site map. These wells should be avoided and protected from damage.

1.4 DEFINITIONS

The terms used in this section are defined as follows:

1.4.1 Jet Grout Panel

A panel of grout slurry mixed with some resultant soil particles not removed by erosive water/air jet. The panel is formed by jetting mono-directional and lifting the jetting rods, however some movement of the jet grout rods moving in an arc of about 20 degrees shall be required at some panels.

1.4.2 Jet Grout Partial Columns

A partial column of grout slurry mixed with some resultant soil particles not removed by an erosive composite water/air jet. The partial column is formed by jetting in an arc of about 120 degrees while incrementally lifting the jetting rod. The partial column is installed in-line with the drill hole of the column centers, shown on sheet C-3. The drill hole spacing between adjacent partial columns is also shown on sheet C-3. The sweeping motion of the partial column is used to fill in any potential gaps between adjacent columns on the primary line and create a more uniform cutoff wall. The partial column may be installed over a selective depth of treatment (i.e. gravel and or cobble layers and or below the ground water

table). The Contractor shall demonstrate this method in the Jet Grout Test Section of this contract.

1.4.2.1 Jet Grout Partial Column Alternate Option

As an alternative to the definition in paragraph 1.4.2, the overlap between adjacent primary row columns can be filled-in by a jet grout method selected by the Contractor as long as the effective zone of treatment for the partial column alternative shall result in a plan area equivalent to the crossed hatched area shown on sheet C-3. The partial column alternate option may be installed over a selective depth of treatment (i.e. gravel and or cobble layers and or below the ground water table). This option may be used based upon evaluation and execution by the Government.

1.4.3 Drilling Deviation Measurements

Drilling deviation measurements are performed using an instrument capable of biaxial measurements to determine the magnitude of all borehole deviations. The biaxial instrument for measuring the drilling deviations of the jet grout hole shall be able to fit inside the triple fluid jet rods or be attached to the bottom of the rods. The biaxial inclinometer for all the coreholes and rotary exploratory boreholes shall be able to fit along the entire length of a minimum 102 millimeter (4-inch) diameter hole.

1.4.3.1 Instrumented Drilling Deviation Tests

These tests are performed using the jet grouting drill and instrumentation to record all the drilling parameters typically recorded prior to jet grouting, see specification Paragraph 3.1.3. The purpose of these tests is to obtain the drilling characteristics and borehole deviations for the soil conditions along the levee. There are an estimated 6 sites where these drilling tests will be performed. No jet grouting will be done. However, the boreholes will be cemented shut.

1.4.4 Jet Grouting

Jet grouting, as defined in this specification, shall consist exclusively of a triple fluid system, in which the jet rods are designed to inject three different fluids; air, high pressure water and pressurized cement grout through jets. This process excavates soil using an air/water jet(s) and grout injection using a jet located below the point where the air/water jet is located. The triple fluid jet rod is lifted and rotated at a slow constant incremental speed to achieve thorough mixing and a consistent continuous cylindrical geometry. Mono-directional injection shall be used to form panels. There are three major types of triple fluid jet grout elements planned for testing: jet grout columns with a maximum diameter of 2.5 meters (8 feet), panels with a maximum length of 4 meters (13 feet), and a special partial column to in-fill the gaps between adjacent jet grout columns and also make the cutoff wall more uniform in thickness. There may be a limited number of tests, during Phase 2B, in which the compressed air is not used during the triple fluid injection. The maximum depth of injecting for all elements is about 20 meters (65 feet).

1.4.5 Jet Grouting Specialist

The Contractor or their sub-Contractor shall have a jet grouting specialist with at least three years continuous experience in the last 5 years in triple fluid jet grouting on projects of similar scope and magnitude. This individual shall be on site for the entire project and shall be in technical control of the project. The jet grouting specialist shall be knowledgeable in all aspects of jet grouting including but not limited to (1) control and monitoring of grout placement; (2) mixing methods required to properly mix grout; (3) a thorough knowledge of construction equipment, (4) air pressure and water volume control; and (5) testing required for the jet grout cutoff wall construction quality control.

1.4.6 Jet Grout Column

A nearly cylindrical column of grout slurry mixed with some resultant soil particles not removed by the erosive composite water/air jet. The triple fluid column sizes planned for testing range from 1.5 to 2.5 meters (5 to 8.2 feet) in diameter.

1.4.7 Cut Embankment

The cut embankment shall consist of native soil at the test site, in which the Contractor cuts the soil to the general dimensions shown on sheet C-4 of the contract drawings.

1.4.8 Jet Grout Operator

Individuals with at least 3 years experience in the past 5 years in the operation and maintenance of jet grouting drills, grouting plants, and high pressure pumping equipment required to perform triple fluid jet grouting.

1.4.9 Slotted Steel Casing and Lexan Liner

As part of the field QC/QA procedure a slotted steel casing with Lexan liner will be fabricated and installed at selected locations, as shown in the drawings. The purpose of the slotted steel casing and Lexan liner is to allow a borehole camera to be placed inside of a protective Lexan liner which protects the camera against damage from the jet grout. The camera is then lowered inside of the Lexan until the camera is at a slot in the steel casing. The camera will then be used to detect the arrival of the jet in the view finder of the camera. As the jet grouting continues the camera is lifted to the next viewing point to repeat the detection of the jet grout against the Lexan. The steel casing will be encapsulated by jet grout columns placed on each side of the slotted steel casing.

After a sufficient curing period the Lexan inside of the pipe will be reamed out for purposes of performing a water pressure packer test (double packer) from inside of the slotted steel casing. The open slots on the steel casing will allow water to permeate into the soil-cement of the jet grout column.

1.4.10 Borehole Camera

The borehole camera shall be used in conjunction with the slotted steel

casing and Lexan liner for purposes of detecting the jet grout distance and amount of time required to travel between the point of injection and location of the slotted steel casing. The borehole camera shall be capable of fitting inside of a 0.08 meter (3.25 inch) diameter hole (or less). The camera shall also be capable of viewing out the slots in the sidewalls of the steel casing.

A second use of the borehole camera will be to photograph the inside of core holes and rotary exploratory holes drilled into cured soil-cement formed by the jet grouting process. The camera will be used over the entire length of the hole.

1.4.11 Borehole Camera Specialist

Individuals with at least 3 years experience in the past 5 years in the operation and maintenance of borehole cameras and field operated video taping equipment.

1.4.12 Rotary Exploratory Drilling

Rotary exploratory drilling (such as tri-cone Tungsten roller bit) shall be selected by the jet grouting contractor to produce a minimum 102 millimeter (4-inch) diameter borehole using only water or air as the drilling fluid. The borehole shall be able to accommodate the borehole camera required in this specification.

1.4.13 Triple Fluid Jetting Monitor

The triple fluid jetting monitor is the rod appliance which holds the water, air, and cement jets.

1.4.14 Jet Grout Corridor

The jet grout corridor is the area in the jet grout test section, Test Phase 2A, which is 3 meters wide and surrounded by in-situ instruments as shown on sheet C-3.

1.5 SUBMITTALS

Government approval is required for all submittals with a "G" designation; submittals not having a designation are for information only. Submittals shall be sent to the Government at least ten days prior to commencement of any mobilization of jet grouting equipment for test section work except where noted otherwise in this specification, especially in Paragraph 1.7, SCHEDULE shall control. The following shall be submitted in accordance with specification 1034/1189, SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Jet Grout Equipment; G

Submit data on all equipment to be used in the construction of the jet grout bodies and equipment to be used in the Contractor's construction quality control testing shall be included, especially details concerning

the in-hole instruments for measuring drilling deviations of the triple fluid rods. Project case history data shall be presented to show that the proposed equipment is capable of performing the experimental work, especially 2.5 meter (8.2 feet) diameter columns and partial columns. The Contractor will comment on the capability of the equipment to form a 4 meter (13.1 feet) long triple fluid jet grout panels, and indicate the maximum length of panel their equipment can form (by providing previous case history evidence). They shall also comment on their equipment capabilities to form partial columns with a rod rotation to produce an arc angle of 120 degrees, and to form panels with a slight sweeping motion to produce an arc angle of 20 degrees or state the minimum sweep angle possible with their drill. Methods for drilling and supporting the boreholes shall be included especially the capabilities of the triple fluid jet rods to be drilled through the gravel-cobble layer.

Instruments for Drilling Deviation Measurements

Submit data on all instruments to be used for drilling deviation measurements, including manufacturer's operating manual. In particular, Contractor will provide details concerning the operation and data reduction of the instruments used for measuring drilling deviations for the triple fluid jet rods. Contractor shall submit previous jobs in which instrumentation was used along with sample data collected from the project. Data comparing the triple fluid jet rods instrument with a standard inclinometer shall be provided.

Control and Disposal of Jet Grout Waste; G

The contractor shall submit a specific waste management plan for control and disposal of all jet grout waste. Contractor shall provide estimates of waste generation for the site. Contractor shall show the location and volume capacity of all temporary storage pits or containers along with proposed liners for in-ground temporary storage pits. Data on and use of diverters to control the movement of the cuttings shall be submitted. Methods of excavating and transporting jet grout waste from the site shall be included. Contractor shall specifically address how solid waste and liquid waste will be handled and disposed of off the site.

In-Situ Water Pressure Testing; G

Data on equipment and procedures used for conducting the in-situ water pressure testing. Data on equipment shall include the packer system, appliances for applying water pressure, all gages for pressure and flow rate, and data reduction methods and analysis.

Equipment and Procedures for Rotary Exploratory Drilling; G

Data on equipment and procedures used for performing the rotary exploratory drilling.

Equipment and Procedures to Obtain Samples; G

Data on equipment and procedures to obtain cutting samples and cored

samples. Cored samples of cutoff wall (soil-cement) shall consist of a minimum 102-millimeter (4-inch) diameter cored samples of hardened soil-cement obtained in 1.5-meter (5-foot) long runs. Split inner tubes will be used for core removal. Coring system shall be equivalent to Christensen Products large diameter convertible coring system (146 millimeter by 102 millimeter or 5.75 inches by 4 inches). The cored hole sample locations and time of coring cured soil-cement will be determined by the Contracting Officer.

High Pressure Operating Safety Manual; G

The Contractor is responsible for site safety. The Contractor will establish safety protocols and provide safety training to all personnel on-site as related to operating and working within the vicinity of high pressure pumps, lines, valves, etc. As a minimum, the safety manual will contain names, telephone numbers and also manufacturer's certificates related to safe operating pressures for all lines, valves, connections, blow-off valves and any other items which operate under high pressure (above 7 MPa; 1000 psi). The manual will contain pump pressure characteristics used for the project, including: pressure-flow-transmission setting curves for high pressure pump, and piston size. Manual will have the name, phone numbers, and off-site location of Contractor appointed high pressure safety officer. Each member of jet grout crew will sign the safety manual after receiving appropriate instruction. Submit safety manual at least 21 calendar days prior to commencement of any mobilization of jet grouting equipment for the jet grout work. Any safety infractions and or incidences, no matter the severity shall be kept as a log entry in the safety manual. A copy of the current manual shall be available on site for review by the Government Quality Assurance inspectors.

Contractor shall submit sketches and manufacturer's operating manual on safety valves to control maximum pressure in jet grouting line.

Contractor shall submit details of how operators at the drill rig will keep in constant communication with the high pressure pump operator. Due to the sensitivity with injecting in a levee embankment, the Contractor will have a communication system which will not rely upon hand held devices, and has a high level of assurance that high pressure pumping can be stopped quickly (i.e. 10 seconds).

Due to the difficulty with keeping the site secured from pedestrian access, the Contractor will develop a positive means for isolating all high pressure lines from inadvertent pedestrian access or injury. Positive means of isolation may include: use of appropriately sized steel pipe and fittings; direct burial of the high pressure lines surrounded by barriers and signage; and insertion of high pressure hoses inside appropriately sized steel pipe. These isolation methods shall be used for high pressure pumping from the grout plant to the jet grout working area. High pressure hydraulic hoses certified by the manufacturer will only be allowed for use unprotected at the surface in the actual jet grout working area.

Plans of Action For Response Value; G

Submit within 3 weeks after the Notice to Proceed for review generalized

plans of action to be implemented in the event any Response Value, as specified in Paragraph 3.4.2, "Displacement Response Values" is reached. The generalized plans of action shall be positive measures by the Contractor to do any or all of the following that is or are applicable:

1. Stop jet grouting immediately.

2. Submit plan to proceed forward with jet grout test section such that the 7-millimeter (0.25-inch) maximum displacement (lateral or ground heave) will not be exceeded.

3. The cut embankment test series is excluded from these requirements since the blow-out of the jet from the side slopes of the embankment might have a very high probability depending on the distance of the guide hole from the hinge point of the cut embankment (See paragraph 1.2.2).

SD-04 Drawings

Jet Grout Test Section Construction; G

The layout of operations for the jet grout test section construction shall include but is not limited to drawings for grout mixing equipment, injection equipment, pumps, hoses, lines, waste areas, and the location of jet grouting for Phase 1 and Phase 2 with respect to support equipment.

Shop Drawings for Slotted Steel Casing with Lexan Liner; G

Contractor shall submit shop drawings used to fabricate the slotted steel casing and Lexan liner. Details concerning the 76-millimeter (3 inch) slots, connection between runs of pipe, and capability of the pipe joints to allow slots to be aligned for a 20-meter (65-foot) string shall be shown in the drawings.

The shop drawings shall also show the details of the seal between the inside diameter of the steel casing and Lexan liner inside of the steel casing.

Borehole Camera; G

As part of this submittal the Contractor shall show the detail drawings for the borehole camera for use inside all the core holes, rotary exploratory holes, and Lexan liner. Manufacturer's data specification sheets shall be included in the submittal for review, in particular capabilities of the encoder to stamp video tapes in real time. Three copies of video tapes for all borehole camera surveys shall be submitted within 24 hours of performing the survey.

SD-07 Schedules

Schedule and Sequence of Operations; G

It shall be required to perform the trial field in the sequence of Phase 1 and then Phase 2. The five test series in Phase 1 shall be performed in the sequence specified. The general work sequence and schedule submitted

by the Contractor shall include, but are not limited to: mobilization and site preparation, Phase 1 and Phase 2 of the jet grout test section, waste management and disposal, and site restoration.

SD-09 Reports

Quality Control Testing and Reports

Reports of inspections or tests, including reduction of raw data, organization, and presentation of graphs and plots shall be included. Test methods used shall be identified and recorded along with test results. Quality Control test results shall be submitted within 24 hours of completion of tests. Daily recorded information shall include but is not limited to hard copy output and floppy disk containing digital record from each jet grouting column and any borehole surveys conducted during the shift. Digital record shall contain:

1. Summary page containing:

a) basic project information, date, length, hole identification

b) data on drilling operations including start and end time, drill rod and bit sizes, maximum depth, top of aquiclude, drilling method, any fluids, total hole deviation at the hole bottom.

c) grouting operations start and end time: top/bottom of columns, average jetting parameters, total weight of dry materials injected, total volume of grout injected.

d) any observations during drilling and injecting, other pertinent observations such as grout escapes, ground heave, conformance to target values, or other unusual behavior.

2. Digital file for input into Microsoft Excel Spreadsheet containing the following data scanned continuously:

a) during drilling: clock time, depth, drilling rate, rotary speed, thrust on tool, rotary torque, drilling fluid pressure, and specific energy.

b) during jet grouting: clock time, depth, incremental lift speed water pressure and flow rate, air pressure and flow rate, grout density/pressure/flow rate, and revolutions per minute (rpm)

3. Hard copy and digital file of any drilling deviation borehole survey. Digital file for input into Microsoft Excel spreadsheet shall contain: general project and borehole information, surveyed ground location of injection hole, depth of survey, deviation in transverse and longitudinal directions, and total deviation.

Other records submitted shall include: test samples taken from grout cubes, wet samples of soil-cement, core samples, water pressure tests, permeability, and any other information from construction of jet grout formed during test section.

SD-13 Certificates

Factory Calibrations on Instruments Used for Control of Jet Grouting

A factory calibration shall be done on all instruments used for control of the jet grouting. Certification shall be provided that the test equipment used for this purpose is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements and that, where applicable, are traceable to the National Institute of Standards and Technology. Calibration certificates (obtained for each instrument within one month of start of project) shall be maintained on-site for the duration of the project for the following instruments:

Drilling Instruments:

RPM's (N)	(rev/sec)
Torque transducer (T)	(kN * m)
Thrust on drill rods (F)	(kN)
Drilling speed (R)	(m/sec)

The above drilling parameters will be used to calculate the specific energy versus depth as:

$$E = F/A + 2(P)NT / (A R)$$

where "A" is the cross sectional area of the borehole (m^2), and "P" equals 3.14

The value of specific energy, "E" (kJ/m^3), will be plotted versus the drilling parameters on the same graph for ease of visualization

Jet Grouting Instruments:

water:	pressure, flow rate
air:	pressure, flow rate
grout:	pressure, flow rate, density
depth:	depth indicator

Factory Calibration on Borehole Surveying Instruments

Factory calibration certificates (within one month of start of project) for all borehole surveying instruments.

Cement Certification

Statement signed by an authorized official to certify on behalf of the manufacturer of the cement attesting that the products meet specified requirements. The statement must be dated after the award of the contract, must state the Contractor's name and address, must name the project and location and must list the specific requirements which are being certified.

SD-14 Samples

Jet Grout Samples

Jet grout samples consisting of cored samples, wet grab samples, and cement grout samples taken by the Contractor which are not tested or taken for Government testing shall be submitted to the Contracting Officer.

SD-18 Reports

Survey System; G

A survey system for locating the center of each jet grout drill hole shall be established by the Contractor and submitted to the Contracting Officer for approval. The locating system shall be able to re-locate the drill hole center within 25 millimeters (1-inch) of the location initially used to perform the injection. Submittal shall be stamped by a Land Surveyor registered in the State of California.

Jet Grouting Test Section; G

The Contractor shall submit the test section layout, detailed jetting procedures, and jetting parameters to be used: (all nozzle sizes, pump pressures, flow rates, rod rotation, lift speed, inter-axis spacing, column size, grout formulations, and any other information needed to conduct and monitor the test section).

Submit details related to spoil handling equipment and procedure for removing spoil from test section area including disposing of waste material and dump site selected. All jet grout cuttings must be removed from the site by the end of the test section.

Submit details of how water pressure testing will be accomplished, including drawings of equipment to be used including packers, flow meters, pressure gauges, and data reduction methods.

Results of Cement Grout Mixes with Water Compatibility;G

During all work, Portland Type I/II cement will be used. All cement grout will have a water/cement ratio of 0.70:1, with the exception of Test 5A of Phase 1. Contractor shall prepare grout cubes using cement and water source proposed for the jet grouting using W/C of 0.70:1. The average of three cubes shall have an unconfined compressive strength of at least 7 MPa (1,000 psi) with no strength below 3.5 MPa (500 psi) at 7 days, and 17 MPa (2,500 psi) with no strength below 10.3 MPa (1,500 psi) at 28 days shall be obtained.

The result from these grout cube tests shall be submitted at least 10 working days prior to any delivery of cement to the project.

Final Report; G

All data gathered including but not limited to: column and panel locations in plan and elevation, drilling and injection reports, borehole surveys, water pressure test data, all laboratory data, and an as-built plan and elevation view of the test section shall be continuously maintained by the Contractor. Five copies of the final test section data package shall be submitted within 30 days of completing Test Phase 2B or the date indicated

in Section 00100, paragraph 52-0211-4852, PERFORMANCE PERIOD, whichever occurs first chronologically.

1.6 MEASUREMENT AND PAYMENT

The objective of the jet grout test section is to develop information which will allow the production work to be performed in a safe and cost effective manner. In order to achieve this end, the Contracting Officer may at any time prior to or during construction require a change in the jet grout test section. The change may take the form of: varying the depth of any and all jet grouting, adding additional columns, or totally eliminating tests from the contract due to the experimental nature of the jet grout test section.

Any jet grout hole lost or damaged as the result of mechanical failure of equipment, inadequacy of grout, air, or water supplies, or improper drilling or injection procedures shall be backfilled with cement grout and replaced by another hole, drilled and injected by the Contractor at no cost to the Government. Breakdown of equipment or lack of supplies during any column or panel formation will be grounds for rejection of the column. Additional columns or panels shall be installed by the Contractor at no cost to the Government.

1.6.1 Active Jet Grouting

Measurement for payment for furnishing all labor and equipment to perform drilling and injection for any type of jet grouting as shown in the contract drawings and specified in the specifications shall be based upon an hourly rate. The hourly rate will be measured using the clock time obtained from the data acquisition records generated by the jet grouting drill and independently verified by the Contracting Officer.

The clock time as measured by the data acquisition system will continuously run during active jet grouting stages for each hole. Jet grouting is defined in paragraph 1.4.4. For all other activities, such as: all drilling, drilling deviation measurement, moving the drill from hole to hole within the jet grout staging area, setting up over a diverter, repairing equipment, clearing clogged nozzles, cleaning grout lines between injections, and cleaning of the jet grout drill rods are considered incidental to hourly rate for active jet grouting. The hourly rate shall be based upon working at least a 10-hour shift for a minimum of 6 days a week.

Payment for jet grouting will be made at the contract unit price for Item "ACTIVE JET GROUTING". Such price shall include all costs of plant, labor, equipment, and materials with the exception of cement grout, and all operations necessary to complete the work specified in accordance with the contract specifications and drawings.

1.6.2 Standby Jet Grouting

Measurement for payment for standby time, as described, for all labor and equipment to perform drilling and injection for any type of jet grouting as shown in the contract drawings and in the specifications shall be based upon an hourly rate. The standby time under this item shall be anytime

that drilling and grouting operations are delayed for the convenience of the Government at the request of the Contracting Officer. It is not to be used for Contractor caused delays, delays due to inadequate personnel, equipment malfunctions, material delivery, any other activity which the Contractor has under their direct control, or adverse weather conditions. Standby jet grouting for an entire workday will be paid at a maximum of 8 hours.

Payment for standby of equipment and labor will be made at the contract unit price for Item "STANDBY JET GROUTING". Standby shall include all costs of grouting plant, labor, and jet grout equipment which is inactive in the jet grout staging area.

1.6.3 Drilling Deviation Tests on Levee

Measurement for payment for drilling deviation tests on levee shall include the cost of all labor and drilling equipment, along with any and all ancillary equipment and labor, required to perform instrumented drilling in conformance with the drawings and specifications and shall be based upon linear meters of borehole drilled, tested, and grouted in conformance with the contract drawings and specifications. Payment for drilling deviation tests on levee shall be made at the contract unit price for Item "DRILLING DEVIATION TESTS ON LEVEE". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, materials, and all operations necessary to complete the work specified in accordance with the contract specifications and drawings.

1.6.4 Standby High Pressure Pumps and Grouting Equipment

Measurement for payment for standby time, as described below, for grouting plant and equipment and high pressure pumps used to perform injection for any form of triple fluid jet grouting as shown in the contract drawings and in the specifications shall be based upon a daily rate.

The standby time under this item shall be strictly applied for the time period in which the drilling deviation tests are being performed on the levee at the direction of the Contracting Officer. It is not to be used for Contractor caused delays, delays due to inadequate personnel, equipment malfunctions, material delivery, any other activity which the Contractor has under their direct control, or adverse weather conditions.

Payment for standby of grouting plant and equipment and high pressure pumps will be made at the contract unit price for Item "STANDBY HIGH PRESSURE PUMPS AND GROUTING PLANT". No labor costs shall be included in this bid item.

1.6.5 Cement Grout

Measurement for payment for cement grout (cement and water) shall be based upon the cubic meter as measured during active jet grouting by the data acquisition system used to monitor the grout flow and density at the grout plant for active jet grouting as shown on the contract drawings and specified in the specifications. Payment for materials to make the cement - water grout for all the test section jet grouting will be made at the

contract unit price for Item "CEMENT GROUT". Such price shall include all costs for material, all grout testings, any transportation, loading and unloading, placement into silos or other storage bins for all cement and water used in the grout formulation. The total volume of water used for the grout preparation, including water used for the high pressure jetting and cleanup, shall be considered as incidental costs to this bid item.

1.6.6 Disposal of Jet Grout Waste

Measurement for payment for disposal of jet grout waste material shall be based upon the metric tons (2200 pounds) of jet grout waste material transported and disposed of at the Contractor's selected landfill as measured from certified public scales in accordance with the contract drawings and specifications.

Payment for disposal of all jet grout waste material will be made at the contract unit price for Item "DISPOSAL OF JET GROUT WASTE". Such price shall include all costs of labor and any and all equipment and materials required for disposal of the jet grout waste material in accordance with the contract drawings and specifications.

1.6.7 Core Drilling

Measurement for payment for coring of the jet grout columns shall be based upon the linear meter unit price in accordance with the contract specifications. Payment for core drilling will be made at the contract unit price for Item "CORE DRILLING". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, and materials, including but not limited to wooden core boxes and all operations, including drilling deviation measurements, and any other operations necessary to complete the work specified in accordance with the contract specifications.

1.6.8 In-Situ Water Pressure Test

Measurement for payment for in-situ water pressure test shall be made for each in-situ water pressure test in accordance with the contract specifications. A stage down test with a stage ranging from 3 to 5 meters (10 to 16.4 feet) shall constitute an in-situ water pressure test. Maximum depth for any test shall be 20 meters (65 feet). Payment for each in-situ water pressure test shall be made at the contract unit price for Item "INSITU WATER PRESSURE TEST". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, and materials, and all operations necessary to have the capability of simultaneously perform at least two (2) in-situ water pressure tests and complete the work specified in accordance with the contract specifications.

1.6.9 Unconfined Compressive Strength Test

Measurement for payment for an unconfined compressive strength test shall be made for each compressive strength test, excluding the cement grout cubes, in accordance with the contract specifications. Payment for unconfined compressive strength testing shall be made at the contract unit price for Item "UNCONFINED COMPRESSIVE STRENGTH TEST". Such price shall

include all costs of plant, labor, equipment, materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.10 Permeability Test

Measurement for payment for permeability test shall be made for each permeability test in accordance with the contract specifications. Payment for a permeability test shall be made at the contract unit price for Item "PERMEABILITY TEST". Such price shall include all costs of plant, labor, equipment, transportation, and materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.11 Slotted Steel Casing with Lexan Liner

Measurement for payment for slotted steel casing with Lexan liner shall be made on a linear meter unit price in accordance with the contract specifications. Payment for testing shall be made at the contract unit price for Item "SLOTTED STEEL CASING WITH LEXAN LINER". Such price shall include all costs of plant, labor, equipment, transportation, and materials, and all operations, including installation, reaming of the Lexan liner, double packer water pressure tests, and drilling deviation tests, necessary to complete the work specified in accordance with the contract specifications.

1.6.12 Borehole Camera

Measurement for payment for borehole camera shall be made on daily rate unit price in accordance with the contract specifications. The daily rate shall be based upon working a 10-hour shift. Payment for the borehole camera shall be made at the contract unit price for Item "BOREHOLE CAMERA". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, materials, three copies of video tapes, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.13 Cut Test Embankment

Measurement for payment for cut test embankment shall be based upon a lump sum unit price in accordance with the contract drawings and specifications. Payment for the cut test embankment shall be made at the contract unit price for Item "CUT TEST EMBANKMENT". Such price shall include all costs of plant, labor, equipment, transportation, materials disposition, and or usage, and all operations necessary to complete the work specified in accordance with the contract specifications and drawings. Backfilling the cut embankment, and removal of the jet grout bodies above the surrounding ground level are considered incidental to these operations.

1.6.14 Excavations

Measurement for payment for excavations to expose the jet grout bodies shall be based upon a lump sum unit price in accordance with the contract drawings and specifications. Payment for all excavations shall be made at the contract unit price for Item "EXCAVATIONS". Such price shall include

all costs of plant, labor, equipment, transportation, materials disposition and or usage, and all operations necessary to complete the work specified in accordance with the contract specifications and drawings. Such price shall include backfilling the excavations as specified in this specification section.

1.6.15 Rotary Exploratory Drilling

Measurement for payment for rotary exploratory drilling of the jet grout cutoff wall shall be based upon the linear meter unit price in accordance with the contract specifications. Payment for rotary exploratory drilling will be made at the contract unit price for Item "ROTARY EXPLORATORY DRILLING". Such price shall include all costs of mobilization and demobilization, plant, labor, equipment, and materials, including but not limited to all operations, including drilling deviations measurements, and any other operations necessary to complete the work specified in accordance with the contract specifications.

1.6.16 Fabrication of Cuttings

Measurement for payment for fabrication of jet grout cutting samples shall be made for each sample fabricated in accordance with the contract specifications. Payment for fabrication of jet grout cuttings shall be made at the contract unit price for Item "FABRICATION OF CUTTINGS". Such price shall include all costs of plant, labor, field tests specified in paragraph 3.7.1.2, equipment, including an electric motor driven Fann Viscometer, temporary storage, transportation, and materials, and all operations necessary to complete the work specified in accordance with the contract specifications.

1.6.17 Partial Column Alternate Option

Measurement for payment for furnishing all labor and equipment to perform drilling and injection for jet grouting the partial column alternate option as shown in the contract drawings and specifications shall be based upon an hourly rate. The hourly rate will be measured using the clock time obtained from the data acquisition records generated by the jet grouting drill and independently verified by the Contracting Officer.

The clock time as measured by the data acquisition system will continuously run during active jet grouting stages for each hole. Jet grouting partial column alternate option is defined in paragraph 1.4.2.1. For all other activities, such as: all drilling, drilling deviation measurement, moving the drill from hole to hole within the jet grout staging area, setting up over a diverter, repairing equipment, clearing clogged nozzles, cleaning grout lines between injections, and cleaning of the jet grout drill rods are considered incidental to hourly rate for active jet grouting. The hourly rate shall be based upon working at least a 10-hour shift for a minimum 6 days a week.

Payment for jet grouting will be made at the contract unit price for Item "OPTION D, PARTIAL COLUMN ALTERNATE METHOD". Such price shall include all costs of plant, labor, equipment, and materials with the exception of cement grout, and all operations necessary to complete the work specified

in accordance with the contract specifications and drawings.

1.7 SCHEDULE

The Contractor shall concentrate efforts on site preparation and mobilization to the site with the following milestone dates identified in the submittal for schedule and sequence of operations. The milestones for all the Test Series (Tests 1, 2, 3, 4 and 5) are critical to the successful completion of the jet grout test section. All submittals associated with the Test Series shall receive an expedited review from the Government consistent with the schedule. Commitment of at least 10 hours per day for a minimum 6 days per week is applicable when active jet grouting occurs. All other scheduling for hours and days shall be developed by the Contractor in order to meet the following milestone dates.

a). Within 3 calendar days from the Notice to Proceed (NTP), Contractor shall have submitted permit application to obtain a Haul Road Crossing Application from Union Pacific Railroad.

b). Within 3 calendar days from the Notice to Proceed (NTP), Contractor shall identify the primary water source for performing the jet grouting. Any and all permits required for obtaining water for the project shall be submitted within 10 calendar days from the Notice to Proceed.

c). The Contractor shall submit shop drawings for fabrication of the slotted steel casing with Lexan liner and identify source for the borehole camera within 7 calendar days from the Notice to Proceed (NTP).

d). The Contractor shall satisfy the requirements for fabrication and start the demonstration of the 20-meter (65-foot) of slotted steel casing with Lexan liner and borehole camera within 30 calendar days from the Notice to Proceed (NTP) and shall precede Test 1 of Phase 1 of the jet grout test section by at least 10 calendar days.

e). The Contractor shall start Test 1 of Phase 1 within 40 calendar days from the Notice to Proceed (NTP).

f). The Contractor shall complete Tests 1, 2, and 3 within 60 calendar days from the Notice to Proceed (NTP).

g). The Contractor shall complete Test 4 within 65 calendar days from the Notice to Proceed (NTP).

h). The Contractor shall complete the entire testing (Tests 1 through 5, Test Phases 2A and 2B) for the jet grout test section within 100 calendar days from the Notice to Proceed (NTP).

The Contracting Officer reserves the right to modify the work and schedule in order to meet the overall objectives of the jet grout test section.

PART 2 PRODUCTS

2.1 MATERIALS

The Contractor shall maintain at the job site a sufficient quantity of raw materials and other supplies such that the work can proceed uninterrupted by material shortages. The grout to be used shall be suitable for the project. The Contractor shall work with the government to modify the jet grout mix to meet the target material performance estimated for unconfined compressive strength and and hydraulic conductivity (permeability) as defined and established in the "Results of Cement Grout Mixes With Water Compatibility" submittal report and specified in Paragraph 3.4, "TEST SECTION FIELD TARGETS FOR JET GROUTING".

2.2 CEMENT

The cement shall be free flowing and not contain lumps which would clog the jets. Cement shall be Portland Cement Type I or Type II (per ASTM C 150). A written certification specifying cement quality shall be provided by the cement supplier and the Contractor shall provide a record copy to the Contracting Officer.

2.3 ADMIXTURES

Admixtures may be used in the mix, provided they be shown necessary to satisfy coreability, permeability or other technical requirements and approved by the Contracting Officer. The Contractor shall have on file a written statement as to the use of any such admixture, its effect on the grout mix, its long-term stability, and its effect on the environment.

2.4 WATER

The Contractor shall supply all water required for mixing the grout, cleaning equipment, and all other purposes needed by the Contractor. Any and all equipment, trucking, and piping required to transport water to the site will be the responsibility of the Contractor. Contractor is responsible for obtaining all required permits.

Water from the landfill may also be available. The Contractor shall make arrangements with John Olesen at (916) 264-7432 and pay any fees in advance.

The water shall be tested at the start of construction from each source and shown to be free from oil, organics, acids, alkali, or other deleterious substances. The water shall be free of turbidity, clean, fresh, and comply with the standards set below:

a. A pH equal to 7.0 plus or minus 1.0.
b. Total dissolved solids not greater than 500 parts per million.
c. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.
d. Hardness less than or equal to 50 ppm (Recommendation Only).

Once a week the temperature of the grout mix water contained in any storage tanks shall be taken and recorded.

2.5 MATERIAL STORAGE FACILITIES

The Contractor shall provide all necessary materials, equipment and

personnel to store cement and proposed admixtures under conditions to prevent moisture or other contaminants from mixing with the materials prior to use in the grout mix.

2.6 CUT EMBANKMENT BACKFILL

During Phase 2 of the test section, the Contractor will be required to cut a 3 meter (10-foot) high test embankment into native soil. The soil shall be stockpiled at the site and used to backfill the cut excavation once the Phase 2 series are completed. The backfill operations shall compact the native soil to at least 90% of maximum density as determined by ASTM D 698.

2.7 ENVIRONMENTAL PROTECTION

The raw materials and other supplies used in the construction of the jet grout cutoff wall and any temporary jet grout waste disposed of within the project limits or at any landfill shall be non-hazardous and shall comply with specification 1034/1189, SECTION 01355 ENVIRONMENTAL PROTECTION to prevent, and provide for abatement and control of, any environmental pollution arising as a part of the work.

2.8 SLOTTED STEEL CASING AND LEXAN LINER

The target size of the slotted steel casing with Lexan is 102 mm (4 inch) diameter steel pipe or less. The actual diameter of the casing shall be selected by the Contractor and be capable of having a borehole camera, (see Paragraph 1.4.10) lowered inside of a 20-meter (65 foot) long string of casing. A second requirement for the casing diameter shall be related to the need to perform double packer tests inside the slotted steel casing once the Lexan liner is reamed out of the steel casing.

Lexan is a product manufactured by General Electric and is a poly-carbonate class of plastic. Lexan can be obtained from plastic suppliers.

The casing shall be fabricated in lengths such that a minimum of 76 mm (3 inch) wide slots can be formed continuously along the pipe to within 305 mm (12 inches) of the end of the pipe. The 76 mm (3 inch) slot is measured along the circumference of the pipe. A second 76 mm (3-inch) wide slot shall be formed along the casing at 180 degrees from the first slot.

The fabrication of the slots and selected length of casing shall produce a slotted casing which retains its circular shape to allow insertion of a Lexan liner to cover the slots in the casing.

The Contractor shall provide minimal essential interruption of the continuous slot in order to provide the maximum viewing area with due consideration of the need to view materials being jet grouted; the interval and width of packer to be used, and the need to effectively remove the Lexan lining without damaging the steel casing.

The coupling between pipe segments shall produce a flush joint inside and out which is capable of forming a water-tight seal between pipe segments, and also provide for alignment of the 76 mm (3 inch) slots along a 20-meter (65-foot) string of steel casing. The 20-meter (65-foot) is the longest

string of casing required for the jet grout test section. The shortest length is approximately 6 meters (20 feet). The alignment of the pipe sections will permit viewing of the jet grouting via a borehole camera for a maximum depth of 20 meters (65 feet). The lowest section of steel casing will have a water-tight cap to close off the bottom of the pipe string and prevent jet grout from entering inside of the Lexan lined slotted steel casing.

The slotted steel casing shall have a Lexan liner which will have an inside opening to allow entry of a borehole camera for purposes of viewing the impact of the jet grout against the face of the Lexan. The ends of the Lexan shall be sealed against the inside face of the slotted steel casing to prevent jet grout from entering inside of the Lexan and slotted steel casing.

The Contractor shall have a tool which has the capabilities of reaming out the Lexan from inside the steel casing for a length of 20 meters (65 feet).

Prior to performing any fabrication the Contractor shall submit shop drawings for approval of the slotted steel casing and Lexan liner assembly, as per Paragraph 1.5 SD-04, DRAWINGS.

2.9 BOREHOLE CAMERA

The borehole camera shall meet the following:

1. Camera and all attached appliances shall fit within any core hole and rotary exploratory hole used on the project and within the inside diameter of the Lexan liner utilized in the manufacture of the slotted steel casing specified in Paragraph 2.8 and submitted under Paragraph 1.5. Camera shall be able to easily pass through the entire length of all the holes.

2. Camera must be capable of operating to a maximum depth of 30 meters (100 feet) of water (43 psi water pressure), and operating temperature of 65 degrees Celsius (150 degrees Fahrenheit).

3. Camera shall be capable of pan/tilt and 360 degree rotation in a horizontal plane when suspended vertically inside the borehole and Lexan liner specified above under item 1. An alternative pan/tilt and 360 degrees rotation of the camera field of view can be submitted subject to approval of the Contracting Officer.

4. Video camera and monitor shall be color and high resolution. Monitor shall be a minimum size of 9 inches.

5. VCR shall be at least 4 head with S-VHS input with toggle and freeze frame display.

6. Camera must be capable of operating inside the borehole and Lexan liner as specified under Item 1 for a minimum of 4 hours without fogging or condensation during active jet grouting.

7. Camera shall be able to focus clearly through sidewalls of the Lexan

plastic tube without focusing or glinting problems. Lexan has 88% light transmission and refractive index of 1.58 . The camera shall have variable lighting and remote focusing capability.

8. Camera shall be self-focusing or remotely controlled manually. Lens to be self-defogging when operating in a hot and moist environment.

9. Controller will project on color monitor and stamp videotape with the following information in real time: hole or location identification, clock time (resolution to 1/30 second or better), and location (depth and orientation).

10. The Lexan will have elevation graduations and N-S-E-W directions markings on the inside such that it is readable from the camera inside the borehole.

11. For bore holes formed by coring or rotary method, the compass orientation (N-S-E-W) of the field of view shall be estimated for each elevation in which a camera survey is conducted.

12. A dye injector appliance shall be an add-on which shall be attached to the frame of the borehole camera. The dye injector shall be able to inject a small amount of dye below the view finder of the camera. The dye injection shall be able to be performed manually from the surface.

13. As part of the camera equipment, the Contractor shall provide 2 Cole Parmer battery operated thermistor thermometers (dual probes, plus four (4) 30.5 meter (100 feet) long (each) deep water thermistor probes or technically equivalent.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 General

The Contractor shall furnish all necessary plant and equipment for the jet grout test section construction including the preparation for and completion of the drilling deviation tests and Phases 1 and 2 of the test section. All equipment used for drilling boreholes; lowering, raising and rotating the jet rods; mixing grout; supplying pressurized grout and air-water to jets; and jet rods used to construct the jet grout columns shall have proven performance records for use in jet grouting work. The Contractor shall obtain and maintain at the job site spare parts and backup equipment to maintain jet grouting equipment in satisfactory operating condition to prevent loss of time due to mechanical breakdown or equipment failure.

3.1.2 Slotted Steel Casing with Lexan Liner and Borehole Camera Demonstration

Once the 20-meter (65-foot) run of slotted steel pipe and Lexan are fabricated the Contractor shall notify the Contracting Officer and arrange for a demonstration. This demonstration shall begin within 30 calendar

days from the Notice to Proceed (NTP) and shall precede Test 1 of Phase 1 of the jet grout test section by at least 10 calendar days. The demonstration will involve drilling a 20-meter (65-foot) borehole, lowering the slotted casing into the hole, filling the casing with water and lowering the borehole camera into the hole. The camera will be operated and video of the inside of the slotted steel casing shall be taken.

After the borehole camera is removed from the slotted steel casing, a borehole inclination survey shall be performed. The device proposed by the Contractor to measure drilling deviations of the jet grouting rods shall be used to measure the deviation of the camera borehole. A second drilling deviation measurement shall be taken with a calibrated inclinometer device such as manufactured by Slope Indicator Co., Bothell, WA or Geokon Instruments, Lebanon, New Hampshire. The Contractor shall also perform calibration deviation check tests within the two existing inclinometer holes at this time.

During this demonstration it is required that the Contractor prove that the camera operator can operate from a safe distance since the camera borehole will be approximately 1 meter (3 feet)from the jet grout rig. Alternatively, the Contractor will place a moveable barrier to provide protection to the camera operator. If required, the barrier shall be placed in the vicinity of Test 1, Phase 1 of the jet grout test section.

Upon the completion of the above test, the Contracting Officer may direct the Contractor to make modifications in their design to accomplish the required tasks prior to the fabrication of the remaining slotted steel casing or borehole camera submitted.

3.1.3 Jet Grout Drilling Equipment

Jet grout drilling equipment shall be of the type and capacity suitable for drilling in materials at the site and of the required hole sizes and depths. Jet grout drilling equipment shall be suitable for drilling the jet rods to the depths required, then raising and rotating the jet rods to the depths and at the rates required for cutoff wall construction. If the drilling deviation instrument is attached to the jet rods, then the instrument must remain operational for the entire depth of the hole. The borehole shall be stable and have sufficient annular space between the triple fluid jet grout rods and the side walls of the drill hole to be able to maintain a constant flush of cuttings to the surface. Drilling technique shall be able to achieve a maximum target drilling deviation of 1% or less. The presence of cobbles up to 0.3 meters (12 inches) as indicated by bulk samples from project soil-cement-bentonite cutoff wall construction will necessitate drilling equipment capable of drilling through these materials. The equipment shall be capable of drilling and jet grouting to depths up to 30 meters (100 feet).

The jet grout drill shall have an integrated data acquisition system which during drilling will continuously monitor the following:

a. Clock Time
b. Drilling Speed (meters per second)
c. Thrust on Drill Rods (Kilo-newton)

d. Torque (Kilo-newton - meter)
e. Drill Rod RPM's (revolutions per minute, or indicate sweep angle)
f. Drilling Fluid Pressure (Mega-Pascal)
g. Specific Energy (kJ/m^3)

3.1.3.1 Partial Column

The drilling equipment for the partial column shall have the capabilities to form partial columns by rotating the rods in about a 120-degree arc and panels by rotating the rods in a sweeping motion to form about a 20-degree arc. If the Government exercises the partial column alternate option then Contractor shall submit details concerning the partial column submitted in the RFP.

3.1.4 Triple Fluid Jet Rods

The triple fluid jet rods shall have the capacity to be drilled through the gravel-cobble layer and then be used to convey the air, water, grout pressures and flow rates required to produce grout columns or panels in the work site soil types identified in the contract documents, and of the size and depth indicated in the specifications and drawings.

Additionally, the triple fluid jet rods shall have the capacity to accommodate a biaxial instrument for measuring the drilling deviations of the triple fluid jet rods. The instrument shall be able to fit inside the triple fluid jet rods or be attached to the bottom of the rods.

3.1.5 Grout Mixing and Injection Equipment

Grout mixers, holding tanks, water tanks, air compressors, and pumps shall be of sufficient capacity and design to ensure adequate supply of homogeneous grout, air, and water delivered at the required pressure to the jet rods for a full work shift to produce grout columns of the required quality and dimensions.

The grout mixing equipment shall have a controlled weighing system for assuring that the dry and wet constituents of the grout are properly proportioned. Grout mixer/agitator will allow easy access for obtaining fresh sample of grout.

Grout plant will have mud balance, API Marsh funnel, and Fann Viscometer driven by an electric motor for manual checking of grout. It is planned to use the Fann Viscometer to measure the viscosity of the cuttings generated. The Contractor shall provide the Fann Viscometer to the Government upon completion of the testing. The Fann Viscometer shall be in working order when transferred to the Government.

Injection equipment required shall have the following MINIMUM characteristics. The Contractor shall evaluate the need for larger high pressure pumps to achieve a 2.5 meter (8-foot) diameter column and 4 meter (13 feet) long triple fluid panel.

1. During triple fluid injection the high pressure pump shall have the capability of continuously pumping water at 45 MPa (6,500 psi) with a corresponding flow rate of at least 100 liters per minute (27 gallons per minute).

2. The cement pump used for the triple fluid system shall be able to continuously pump cement grout (w/c = 0.70:1) at a pump pressure of at least 18 MPa (2,600 psi) and corresponding flow rate of 150 liters per minute (40 gallons per minute).

3. Air flow pressure for the triple fluid shall not exceed 1.8 MPa (260 psi), nor shall the air flow rate exceed 1.5 cubic meters per minute (53 cubic feet per minute).

The above specifications for the pumps and air requirements do not necessarily correspond to the jetting parameters required for the work. Rather these specifications are the MINIMUM technical requirements for the equipment capabilities. If the Contractor believes that they require increased pumping capacity to satisfy the technical requirements of the test section, then they should mobilize larger pumping equipment. The above is a minimum REQUIREMENT.

Jet grout drill shall contain a data acquisition system and appropriate instrumentation to continuously acquire the following jet grouting parameters:

1. Clock Time
2. Water Pressure and Flow Rate
3. Air Pressure and Flow Rate
4. Grout Pressure, Flow Rate, and Density
5. Depth Below Ground Surface, and incremental lift speed
6. Drill Rod rpms or sweep angle for partial columns

The Contractor shall indicate their ability to measure pore fluid pressure at the point of injection (downhole pressure). They shall indicate the cost and schedule for providing this type of measurement.

During jet grouting an LCD (Liquid Crystal Display) or paper strip recorder will be available for government Quality Assurance inspection so that the jetting parameters can be checked manually.

Once the jet grout column has been completed the Contractor will submit a hard copy of the output along with a digital record of the drilling, all deviation measurements and jetting parameters as part of the daily record.

3.1.6 Equipment Weight, Speed, and Width

The weight of drilling equipment to be used on the levee crown shall be limited to a maximum track vehicle weight of 25,000 kilograms (55,000 pounds). Any trucks operating on the levee crown shall have a maximum gross loaded axle weight of 8,165 kilograms (18,000 pounds). The maximum operating speed of all equipment used on the levee crown roads shall be 24.1 kph (15 mph). The maximum overall width of jet grouting equipment used shall be limited to 3.6 meters (12 feet).

3.2 TRAFFIC CONTROL

The Contractor shall submit to the Contracting Officer a traffic control plan for mobilizing their equipment and accepting deliveries of material through the City of Sacramento Landfill, Harbor Sand and Gravel, and across the Union Pacific Railroad track, which is the only reliable access into the site. See also specification 1034/1189, SECTION 01500, subparagraph 1.6.3. The Contractor shall be required to obtain a haul access permit from the Union Pacific Railroad as per specification 1034/1189, SECTION 01500, Paragraph 1.6.2, the railroad has up to 30 days of processing time. The Contractor shall incorporate all Union Pacific Railroad requirements into their traffic control plan.

There is access under the Union Pacific Railroad tracks which does not require a permit. This access is unreliable and susceptible to flooding during the winter.

3.3 JET GROUTING TEST SECTION

3.3.1 Site Preparation

The Contractor shall prepare the test section area to a firm and essentially level condition for passage of the Contractor's machinery and equipment. Access from the levee down into the test area is via a ramp. The Contractor shall make a determination as to the adequacy of the ramp for mobilizing their equipment and accepting delivery of material. Improvements to the site, access ramps and roads shall be at the sole determination of the Contractor and shall comply with permit and environmental requirements.

3.3.2 Surveys and Markers

The Contractor shall provide, install, replace and maintain all layout and necessary construction staking to locate within 25 millimeters (1 inch) the center of any drill holes for jet grout core holes or rotary exploratory holes used during the construction of the test section.

3.3.3 Daily Site Coordination

At the start of each shift, a brief meeting will be held between the Contracting Officer's representatives, Instrumentation Contractor, and Jet Grouting Contractor to discuss the details of the jet grouting work for that shift. The Jet Grouting Contractor shall distribute an updated summary table and brief narrative containing the following:

a. Jet grout columns currently installed and to be installed during the shift.

b. Jet grouting parameters including grout flow rates, rotation speed, and extraction rates, inter-axis spacing for columns to be installed during shift.

c. Provide summary plots of drilling parameters, specific energy profiles,

jet grouting parameters, and drilling deviations measured on jet grout columns from previous shift.

d. Provide estimates of the size jet grout treatments installed on the previous shifts.

e. Discuss any problems and solutions to achieve the target values specified under Paragraph 3.4, "TEST SECTION FIELD TARGETS FOR JET GROUTING".

f. Other items which the Contracting Officer deems necessary to assure a well coordinated job, especially coordination between the Jet Grouting Contractor and Instrumentation Contractor.

3.3.4 Drilling and Jet Grouting Sequence

The Contractor shall select equipment and drilling techniques to assure a stable drill hole. The drill hole shall have sufficient annular space between the jet grout drill rods and the side walls of the drill hole to be able to maintain a constant flush of cuttings to the surface. The presence of cobbles up to 0.3 meters (12 inches) as indicated by the bulk samples obtained from the construction of the soil-cement-bentonite cutoff wall and shown in the contract drawings will necessitate drilling equipment capable of drilling through these materials.

Drilling technique shall be able to keep drilling deviations to 1 percent or less. Drill deviation measurements shall be taken for every jet grout drill hole, core hole, rotary exploratory hole with readings taken every 1.5 meter (5 feet) depth increment. The last reading shall be taken at the bottom of the bore hole.

The Contractor shall continuously record all the drilling parameters listed in paragraph 3.1.3 and provide a plot of specific energy versus depth for each drill hole. The specific energy data shall be superimposed over the soil stratification data reported from the nearest contract boring.

The drilling and grouting sequence shall be such that an adequate distance is left between the freshly installed columns and panels and any new injection. A minimum of approximately 36 hours (or an elapsed time determined from Test 1 of Phase 1 of the Jet Grout Test Section) shall elapse between injecting triple fluid jet grouting next to an installed column. Furthermore, the closest spacing shall be at least three inter-axis spacing or 4.5 meters (15 feet) (whichever is greater) prior to the 36 hour time elapse. The spacing between columns shall be measured from center of installed jet grout column to center of proposed injection.

3.3.4.1 Horizontal and Vertical Alignment Tolerances

The maximum horizontal deviation of the as-installed center of any soil-cement element at the ground surface shall not exceed 25 millimeters (1-inch) from the layout center coordinate, shown on the Contractor's submittal. The vertical alignment of the drill hole shall not deviate in any direction more than one (1) percent from vertical. At the direction of the Contracting Officer, any soil-cement element which exceeds the

allowable horizontal alignment tolerances shall be supplemented with one or more adjacent or overlapping elements, at no additional cost to the Government.

Once drilling is completed to final depth, the Contractor shall measure the drilling deviations for each hole prior to injection. The instrument to measure drilling deviations shall be compared against a calibrated inclinometer device as required in the demonstration specified in subparagraph 3.1.2.

3.3.5 Jet Grouting Waste

During jet grouting the Contractor shall collect and measure the volume of the cuttings from every jet grout body formed. This will be for purposes of estimating the volume of cuttings which needs to be handled during the production work. The requirement for diverters and other specialized collection methods are discussed in Paragraph 1.2 SCOPE.

3.3.6 Test Section Instrumentation

An Instrumentation Contractor has installed various instrumentation under a separate contract. The general location of the instrumentation is shown on contract drawing sheet C-3. The Jet Grouting Contractor shall coordinate all their efforts to assure that the installed instrumentation is not damaged due to drilling and surface operations. The Jet Grouting Contractor is not liable for repair of any instruments damaged when actual jet grouting is performed. The Jet Grouting Contractor is liable for repair of any and all instruments that are damaged due to the setting up and movement of his equipment to each jet grout column or panel location. The surveyed location of each of the instruments shall be provided to the Jet Grout Contractor prior to their mobilizing to the site with the exception of the cut embankment. The instrumentation for the cut embankment, see sheet C-4, shall be installed by the Government and coordination of this work shall be made between the jet grouting contractor and the Contracting Officer.

3.4 TEST SECTION FIELD TARGETS FOR JET GROUTING

The jet grout test section is being performed to refine the technical requirements, such that a reasonable QC/QA program can be executed during cutoff wall production. A prime requirement is to be able to core the jet grout treatment (single row) at the point of overlap and obtain continuous core over the entire length of jet grout treatment. Thereafter, water pressure tests will be performed to verify the quality of the wall. Additional jet grout columns may be required in the vicinity of water pressure tests to assure a sufficient mass of soil-cement is present, especially at deeper depths (20 meters or 65 feet).

3.4.1 General Target Values

Wall Coreability:

Contractor shall form in-situ soil-cement to have sufficient thickness and

strength such that:

1. Core recovery shall be a minimum of 90% of a core run, with the maximum core run being 1.5 meters (5 feet). For all core holes a borehole camera survey shall be performed over the entire length of the core hole.

2. Soil-cement cores shall be retrieved from the top to within 1.5 meters (5 feet) of the bottom of the jet grout column.

3. For all jet grout columns and panels which have drilling deviation measurements the Contractor shall submit the following information on a weekly basis.

a. The Contractor shall submit as-built drawings of the actual position of the jet grout columns and panels, with plan view layouts starting at the surface and thereafter at 5-meter depth increments with the last plan view being the bottom of the wall.

b. The Contractor shall submit weekly tabulated values of effective column diameter (D), inter-axis spacing (I) at working surface, maximum total drilling deviations (e), and depth (z, at 5-meter intervals) for each jet grout column installed. Tabulations shall have a column of (D-I)/e values for each depth increment. Digitized data shall be submitted on magnetic media for a PC in Microsoft Excel format along with a hard copy output. The exact format of the digitized data shall be coordinated with the Contracting Officer.

c. Once the test shaft required in Test Phase 2A is completed, the Contractor shall submit as-built drawings of the actual position of the jet grout columns and cutoff wall formed, with plan view layouts starting at the surface and thereafter at 5-meter depth increments with the last plan view being the bottom of the wall. A 1.02 meter thickness of theoretical cutoff wall (required in Specification No. 1034) shall be superimposed on each plan view along with the trajectory of the drilling deviation of the jet grout hole. Digitized data shall be submitted on magnetic media for a PC in Autocad format along with a hard copy output. The digitized data shall differentiate between primary, secondary, tertiary injection patterns for the primary line of jet grouting. The exact format of the digitized data shall be coordinated with the Contracting Officer.

4. For any rotary exploratory hole, drilling deviations and borehole camera surveys shall be taken over the entire length of the borehole.

5. The Contractor shall submit weekly three copies of the video tape for each borehole camera survey, along with as-built drawings consisting of the actual trajectory of each core hole or rotary exploratory hole superimposed on the theoretical 1.02 meter thick jet grout cutoff wall plan view. All digitized data shall be submitted on magnetic media for a PC in Autocad format along with a hard copy output. The exact format of the digitized data shall be coordinated with the Contracting Officer.

6. All soil-cement retrieved from core runs shall be well mixed cemented soil without any visible air vesicles or untreated soil inclusions. The surface of the core runs shall resist a knife scratch (approximate depth

of 1/16-inch) using moderate pressure on the knife.

7. The cement grout for all jet grouting shall have a water/cement ratio of 0.7:1 (by weight), except Phase 1 Test 5A where noted on sheet C-3. The cement and water shall meet the requirements specified in all appropriate paragraphs covering water, cement and grout.

8. Once the Contractor has demonstrated that their jetting parameters produce the column and panel sizes specified on the contract drawings, then the hydraulic horsepower for the water and cement pumps along with the kilograms of cement injected per linear meter shall not be less than 90% of the value selected by the Contractor. Once these limits have been established they shall be maintained and verified using the data acquired by the data acquisition system.

9. After all QC and QA evaluation has been performed, then the Contractor shall tremie backfill starting at the bottom of the core hole, Lexan lined steel casing, or rotary exploratory drill hole using low pressure cement grout specified in paragraph 3.4.1, part 7.

10. Corehole location shall be at the direction of the Contracting Officer, but normally the corehole will be at the point of overlap between adjacent columns.

The Contracting Officer shall examine all of the jet grouting and drilling deviation records and determine the location for hydraulic conductivity testing of the jet grout cutoff wall. The Contractor may be required to install an additional full cylindrical secondary line of treatment at the intersection of the primary line of the jet grout cutoff wall.

Hydraulic Conductivity:	1x10-6	centimeter/second (maximum value not to be exceeded by 80% of the in-situ water pressure tests (see paragraph 3.7.3.2), and no value shall be greater than 1x10-5) for any individual test

The laboratory hydraulic conductivity testing shall follow the procedure specified in paragraph 3.7.3.1, "Laboratory Testing on Cored Samples". The Contracting Officer shall select the cored samples for testing and the cured time. In general the laboratory hydraulic conductivity testing shall be performed on freshly extracted cores taken between 14 to 28 days after the installation of the jet grout columns. The calculated laboratory hydraulic conductivity shall be performed for record testing of the project.

3.4.2 Displacement Response Values

If at anytime during the jet grouting test section, a lateral displacement measurement from the inclinometers and vertical displacement measurement from the surface deformation monitoring points, SDMPs, equals or is greater than 7 millimeters (0.25 inches), then the jet grouting has exceeded a displacement target value. The jet grout column under construction will be completed, however the Contractor shall submit a plan to proceed forward with construction of the next test section columns to minimize surface and

lateral movements below 7 millimeters (0.25 inches). The Contractor shall continuously observe the area of construction for evidence of distress and take appropriate measures to preserve the integrity of the test section area at all times.

This section does not apply to the cut embankment tests, since there is a high likelihood that the jet may break-out the side of the test cut embankment.

3.5 CLEANUP AND SITE RESTORATION

The Contractor shall continually clean up jet grout wastes, debris and leftover materials resulting from the jet grout test section. After completion of the work, the site shall be cleared of all debris which may have accumulated in the execution of the work. The Contractor shall be responsible for disposal of these materials off site in accordance with all Federal, State, and local regulations and codes.

All excavations at the site will be backfilled using the on site native material and supplementing any additional material with Contractor furnished material similar to the soil types at the site: SM, SP-SM, and ML. The material shall be placed in a maximum loose lift thickness of 0.3 meters or (12 inches) and compacted to at least 90 percent of ASTM D 698. A minimum of three in-place field density tests and a laboratory compaction test representative of the material being compacted in accordance with ASTM D 698 shall be performed. Tests shall be taken near the start, middle, and end of placement.

All instrumentation holes shall be grouted closed by the Instrumentation Contractor. The Jet Grout Contractor shall level all instrumentation risers and covers above the original ground surface at the test cut embankment. The site shall be graded in accordance with SECTION 02000, "MOBLIZATION AND DEMOBILIZATION"

3.6 DISPOSAL OF WASTES

During any of the jet grouting the Contractor will pump all cuttings from the jet grout process into a waste disposal box container. The total cuttings generated per column, panel or partial column shall be measured and recorded for Tests 1B, 2, 3, and 5, of Phase 1, and the partial columns formed in Test 3 and Phase 2A.

A system of measuring the amount of cuttings produced by the jet grouting and temporary storage system should meet the following requirements:

a. The cuttings shall be diverted to a fixed volume storage structure as they emerge from the jet grout hole. A casing with a T-diverter is one possible system for diverting to the fixed volume storage system and is required for certain Test Series as specified under Paragraph 1.2 SCOPE.

b. The cuttings from the diverter system shall be conveyed by pipes to the fixed volume storage structure with little or no loss of material. A fixed volume can be created by using steel plates for the bottom and K-rails for the sides with an interior liner.

c. A fixed volume storage structure that has sufficient volume to measure cuttings generated from a single column is estimated to need a capacity of 20,000 gallons of cuttings (fresh, non-hydrated). The hardened waste shall shall be disposed off site.

The Contractor shall be responsible for disposal of any supernate above hardened jet grout waste, dumping of bins at jet grout test site for temporary stockpiling on the ground covered with an approved liner, and loading/unloading of jet grout waste into trucks for final transport to a certified landfill. Any and all Local, State, and Federal permits required for disposal of the waste grout and cuttings shall be the sole responsibility of the Contractor. As part of the site restoration, all construction debris must be removed from the test site.

3.7 QUALITY CONTROL

The Contractor shall be responsible for project quality control records. Observations, measurements, and tests described in these specifications shall be performed for quality control. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by the Contracting Officer's Representative at any time.

A trailer with moisture and temperature control environment meeting the requirements of the specifications shall be provided for temporary storage of samples. For long term storage of samples, the samples shall be transported to a laboratory having the environmental conditions meeting the specification requirements. Storage of the samples shall be for a maximum of 4 months after completion of the jet grouting.

The laboratory facility and personnel shall meet the requirements specified in specification 1034/1189, SECTION 01451. The laboratory personnel performing the hydraulic conductivity tests on soil-cement materials shall have at least two years of experience testing impervious materials and have performed these tests in sufficient numbers to insure reliability of results. No work requiring testing will be permitted until laboratory test facilities have been approved and or inspected by the Contracting Officer.

3.7.1 Jet Grout Soil-Cement Samples

The Contractor shall provide representative duplicate samples to the Government's QA laboratory, with the exception of the cutting samples. The Contractor shall deliver samples to a Government approved QA laboratory at the direction of the Contracting Officer.

3.7.1.1 Fresh Cement Grout Samples

Uniformity of the grout mixture shall be verified by the unit weight (density) measurements of the mixed grout by mud balance, and the viscosity by API Marsh funnel, taken at the mixing plant. This is to provide a manual check of the Contractor's data acquisition for the fresh grout. These manual measurements shall be taken at a minimum of one per 19,000 liters

(5,000 gallons) of grout mixed and pumped. Three (3) sets of grout cubes (three cubes in each set) for a total of nine (9) specimens will be taken for each jet grout column formed. The preparation of the grout cubes shall be in accordance with ASTM C 109.

3.7.1.2 Fabrication of Cutting Samples

During the test section phase, bulk samples of the jet grout cuttings shall be obtained for every column. Bulk samples shall be collected at three different depths such as bottom, middle, and top of column. Enough wet bulk samples shall be obtained from each depth to fill four (4) ASTM approved cardboard molds, 76-millimeter (3-inch) diameter by 152-millimeter (6-inch) long cylindrical test specimens. The wet bulk sample shall be poured into the molds and rodded or vibrated to remove trapped air pockets and then sealed. The wet bulk density and the cured bulk density shall be recorded for all samples fabricated. The specimens shall be stored in a laboratory constant temperature, saturated environment and also be in accordance with ASTM D 4832, until tested or until otherwise directed by the Contracting Officer.

For at least one column per shift or as directed by the Contracting Officer, wet bulk density, water content, and Fann Viscometer readings shall be taken of sample cuttings generated at the bottom, middle and top of the jet grout column. The Fann Viscometer test shall be performed within sixty seconds of the cuttings being ejected out of the borehole. The temperature before and after the Fann Viscometer test shall be recorded.

3.7.1.3 Drilling of Cored Samples

During the coring operation, information shall be obtained about characteristics of the jet grout cutoff wall that may or may not be apparent from the core recovered from the hole. Observations of the drilling action must be made and reported to present as complete a picture, as possible of the consistency of the cutoff wall. When coring, the Contractor's quality control representative should note the amount of water return to the amount being injected through the drill rods. Careful observation of drill water return changes can indicate a potential defective zone. While the drill rod is rotating, the drill action and rate of penetration shall be noted and recorded. Changes in drilling rate can be related to changes in wall composition and provide complimentary data in areas of poor core recovery. Basic information to be included on each core boring log should include: size and type of core bit and barrel used; bit changes; depth; length; and time for each run; and amount of core actually recovered.

All cored samples shall be a minimum continuous 102-millimeter (4-inch) diameter core samples. Core drilling technique shall be capable of keeping drilling deviations to a value of 1 percent or less. Coring of the jet grout bodies shall be performed by the Contractor or sub-Contractor performing the jet grout work or drilling contractor, experienced in coring cemented soil, having equipment and procedures that minimize drilling deviations, and capable of obtaining undisturbed core samples. In that the core recovery for the jet grout material is unique and the information from coring is critical to the verification of cutoff wall continuity, submittal

data on equipment and procedures requires Government approval.

All core boxes shall be stored in a laboratory moisture room having constant temperature, saturated environment meeting the requirements of ASTM C 511 until tested or until otherwise directed by the Contracting Officer. Other requirements for the core drilling are specified in paragraphs 3.4.1.

All core holes will be measured for deviations once all of the samples have been extracted from the boring, along with the bore hole camera survey. Location and scheduling of coring shall be as directed by the Contracting Officer.

3.7.1.4 Rotary Exploratory Drilling

Rotary exploratory drilling (such as tri-cone Tungsten roller bit) shall be selected by the jetting grout contractor to produce a minimum 102 millimeter (4-inch) diameter borehole using only water or air as the drilling fluid. The borehole shall be able to accommodate the borehole camera required in this specification. Drilling deviations shall be measured for all boreholes. The other requirements for the rotary exploratory drilling are specified in paragraphs 3.4.1. After all QC and QA evaluation have been performed, then the Contractor shall tremie backfill starting at the bottom of the core hole using low pressure cement grout with a w/c ratio 0.70 to 1.

3.7.2 Jet Grout Compressive Strength Testing

3.7.2.1 Fresh Cement Grout

Three (3) grout cubes will have unconfined compressive strength test (ASTM D 4832) performed on samples cured at three (3), seven (7), and twenty-eight (28) days, except samples shall be formed using molds conforming to ASTM C 109. Once a correlation between grout density and strength versus time is developed, then the grout cube testing will be reduced.

3.7.2.2 Strength Tests of Cuttings

Three (3) specimens from each of the columns sampled as specified in Paragraph 3.7.1.2 (one specimen from top, middle, bottom of column) after curing for three (3) days, seven (7) days, fourteen (14) days, and twenty-eight (28) days, shall be subjected to an unconfined compressive strength test (ASTM D 4832). Changes in the testing may be required, as directed by the Contracting Officer. The need for such changes will be determined, based at least in part, on the results of the quality of the specimens tested.

3.7.2.3 Strength Tests of Cored Samples

Test specimens from samples of 102-millimeter (4-inch) diameter core from selected test section columns, with curing periods of seven (7) days

(limited number as directed by the Contracting Officer) with most coring being done between fourteen (14) days and twenty-eight (28) days. Selected samples shall be subjected to an unconfined compressive strength test (ASTM D 4832). Additional testing may be required, as directed by the Contracting Officer. The need for such additional testing will be determined, based at least in part, on the results of the quality of the specimens tested. The strength tests shall be performed on specimens from the same core run used for permeability tests.

3.7.3 Permeability Testing

3.7.3.1 Laboratory Testing on Cored Samples

Test specimens from samples of continuous core obtained from test columns selected by Representatives of the Contracting Officer will be tested for permeability, wherein, three (3) samples (one sample from the top, middle, and bottom of the same column) after curing for seven (7) days (limited number of tests), with most of the samples being tested between fourteen (14) days, and twenty- eight (28) days. Additional testing may be required, as directed by the Contracting Officer. The need for such additional testing will be determined, based at least in part, on the results of the quality of the specimens tested. The permeability tests shall be performed on specimens from the same cored sample used for unconfined compressive strength tests and taken from the zones in which in-situ water pressure testing was conducted. The permeability or hydraulic conductivity shall be performed in accordance with ASTM D 5084. Test shall be performed as described in Method C. Alternatives to Method C may be used only if approval is granted by the Contracting Officer.

The permeability test parameters are as follows:

a. The following back pressure saturation and consolidation stages incorporated simultaneously shall be as follows:

These are the cell and backpressure stages to be applied during the initial application to achieve 10 psi effective confining pressure. The final stage of cell and back pressure will correspond to the pressures which produce a B coefficient equal to or greater than 0.95. In no case shall the cell pressure exceed 100 psi.

Stage	Cell Pressure (psi)	Back Pressure (psi)	Effective Confining Pressure (psi)
1	5	3	2
2	10	8	2
3	20	15	5
4	30	20	10
5	40	30	10
6	60	50	10

b. Saturation shall be confirmed by measuring the B coefficient.

c. The initial gradient used during permeation shall be 20.

d. Plots of the ratio of inflow to outflow, gradient, and hydraulic conductivity versus time shall be required for each test. Lines describing the boundary limits for the termination criteria listed in ASTM D 5084 shall be included on the plots.

e. The permeate liquid shall be American River water.

f. The specimen top cap, bottom cap, and porous end pieces shall have a diameter equal to the diameter of the test specimen +/- 2%. The diameter of the core samples will be a nominal diameter 102 millimeters (4 inches) and approximate length of 152 millimeters (6 inches).

g. Head shall be increased on the inflow end at the bottom of the specimen to a pressure which will develop the gradient specified in part c.

3.7.3.2 In-Situ Water Pressure Testing

The purpose of performing the in-situ water permeability test is to aid in evaluating wall consistency relating to seepage barrier performance. The in-situ water pressure tests in the jet grout bodies shall be performed by the sub-Contractor performing the jet grout work in that the conducting water pressure tests for this material is unique and the information from this test is critical to the test program. Water pressure testing will be conducted as a staged down test, using a single packer for the second stages and deeper. The maximum stage will be 5 meters (16.4 feet). The test stage shall be core drilled and 102-millimeter (4-inch) diameter core retrieved. The borehole will be washed out until clean water flows from the hole. Thereafter, a thermistor temperature probe shall be lowered into the borehole and temperature readings obtained. If the temperatures are acceptable for water pressure testing and operation of a borehole camera, then the Contractor's Quality Control representative will lower the camera into the hole obtaining video footage of the soil-cement in the borehole. Camera will be removed and water pressure test conducted as follows:

1. A low pressure for 10 minutes. This followed immediately by
2. A moderate pressure for the next 10 minutes, then
3. A peak pressure for the next 10 minutes, then the
4. Moderate pressure again for the next 10 minutes
5. The low pressure for the final 10 minutes

The peak pressures used during any stage of the tests shall depend upon the depth of the stage and quality of the core recovered. For planning purposes, the water pressure shall not exceed a peak pressure of 138 kPa gage pressure (20 psi pressure gage pressure) for shallow depths and 551 kPa gage pressure (80 psi gage pressure) for the deepest stage of the test. Maximum depth for any test shall be 20-meter (65-foot).

The Contractor will record information on date, times of testing, top and bottom of stage, gage pressure and pressure at mid-stage, total flow for 10 minute increment, and Lugeon value for each of the five test increments prior to moving to another stage. Additional time may be required for the particular stage prior to drilling the test hole deeper. This will be

determined by the Government Quality Assurance representative in the field.

The second and subsequent stages shall be cored, washed, and have a single packer placed at the top of the stage to be tested. Five step water pressure test shall be conducted as stated above.

During each portion of the water pressure test, pressure-flow-time data will be taken. Flow meter will have sufficient resolution for tests, and should be able to resolve the volume reading to at least 0.1 liter per meter x stage length in meters. Down the hole tubes through the packer shall have a minimum internal diameter of at least 25 millimeters and coupling shall be flush internally. There shall be no restrictions through the system. The hose connecting to the test gear should also at least 25 millimeters and a maximum length of about 1 meter.

Contractor will pressure test system up to 689 KPa gage pressure (100 psi gage pressure) prior to use and verify that there are zero leaks in the lines, fittings, and values used to conduct the water pressure test. The Contractor shall submit method to verify that the single packer does not have by-pass leakage during water pressure test.

Once the water pressure testing for an entire column is completed, then a borehole camera survey of the corehole will be performed again. The survey shall pay particular attention to the locations where the packer was located. This may provide assistance with evaluating if the packer expansion caused damage to soil-cement.

3.7.3.3 Pump Out Test Wells

There are two pump out wells required for the jet grout test section. A well will be used to evaluate the effectiveness of the test shaft formed in Phase 2 part A and the composite column/panel formed in Phase I, Test 5B. Installation and testing of the pump out well shall be in accordance with SECTION 02525, "PUMP OUT TEST WELLS".

3.8 CUT TEST EMBANKMENT AND SITE RESTORATION

Prior to construction of the cut embankment, the Contracting Officer shall coordinate the installation of the instrumentation to be placed on and in the cut embankment, see sheet C-4. The cut embankment will be approximately 3 meters deep with side slopes of 3:1 and 2:1, which are generally the side slopes of the levee embankment. Four (4) jet grout columns approximately 5 meters deep will be installed at varying distances from the hinge point of the cut embankment on the 3:1 side of the embankment. The test series will be repeated on the 2:1 side of the cut. Several jet grout columns formed without air shall also be installed adjacent to the edge of the 2:1 side slope. Additional tests may be required if there are no blow-outs on the side slopes of the embankment. The installation shall mimic the production installation by allowing columns to harden prior to forming a second jet grout column. The jet grouting parameters which "best" represent the production jetting parameters shall be used during the cut embankment test. The W:C = 0.70:1 shall be used during this test series.

For all the columns formed during the cut embankment test series the Contractor shall utilize a diverter pipe for controlling the spoil generated. The diverter shall prevent any spoil from flowing down the face of the embankment. The diverter system shall be capable of pumping the cut spoil into a concrete transit mixer. The total volume of spoil generated during the jet grouting shall be ascertained by weighing the transit mixer before and after each use, and obtaining density measurements of the cuttings generated from each borehole.

Upon completion of the test and examination of jet grout bodies, the site shall be restored using the excavated material. The soil shall be placed in a maximum loose lift thickness of 305 millimeters (12 inches), and compacted to at least 90 percent of ASTM D 698. A minimum of three (3) in-place field density tests in accordance with ASTM D 1556 and a laboratory compaction test representative of the material being compacted in accordance with ASTM D 698 are required. Tests shall be taken near the start, middle, and end of placement.

3.9 EXCAVATIONS

Excavations to expose the jet grout bodies upon completion of Tests 1, 2, 3, and 5 of Phase 1 and Phase 2A will be required. This is to allow for visual examination of the column to column contact. The excavations shall be up to 4.6 meters (15 feet) or to groundwater (whichever is first encountered). The bottom of the excavation shall be 1 meter (3 feet) wide to accommodate people to inspect the jet grout bodies. To insure levee stability, only one side of the jet grout shaft shall be exposed and backfilled before any other side is exposed unless permitted by the Contracting Officer. Based on site conditions encountered and evaluation by the Contracting Officer, more exposed sides may be permitted.

Excavations shall be in accordance with the Corps of Engineers EM 385-1-1, "Safety and Health Requirements Manual", and all Local, State, and Federal requirement, the most stringent requirements shall govern. Any sloping, benching, or support systems shall be designed and stamped by a registered engineer in the State of California. For the shaft, unsupported sides slopes shall not be steeper than 1.5 (minimum) horizontal to 1 vertical.

Upon completion of visual inspection of the jet grout bodies, the excavations shall be backfilled to the before construction original ground elevation and as specified in paragraph 3.8.

3.10 RECORDS

Records shall be maintained by the Contractor for all testing, measurements, and inspections performed to ascertain that the jet grout cutoff wall construction meets the specifications. Required reports, records, and documentation shall be furnished to the Contracting Officer daily. The Contractor's required records are outlined below.

3.10.1 As-Built Plan and Elevation of Jet Grout Test Section

An as-built plan and elevation view of the test section shaft and cut

embankment shall be continuously maintained by the Contractor. These profiles shall be delivered to the Contracting Officer at the end of the shift in which the facility was completed. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing.

3.10.2 Results

The results of all construction quality control testing required in these specifications shall be furnished by the Contractor. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made. All test results used for Quality Control shall be maintained in an electronic data base system compatible with Microsoft Excel. Specification values shall be shown with the test results and shall be updated weekly and provided. Upon completion of the job, an electronic copy shall be submitted.

3.10.3 Construction Log

The Contractor shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made.

3.11 QUALITY ASSURANCE

The Government may collect and perform quality assurance testing on the jet grout test section. The Government testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. All testing procedures being conducted by the Contractor shall be available for inspection by the Contracting Officer at any time.

-- End of Section --